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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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ABSTRACTS 7865–8619

VOLUME 55 **NOVEMBER 1952** NUMBER 659

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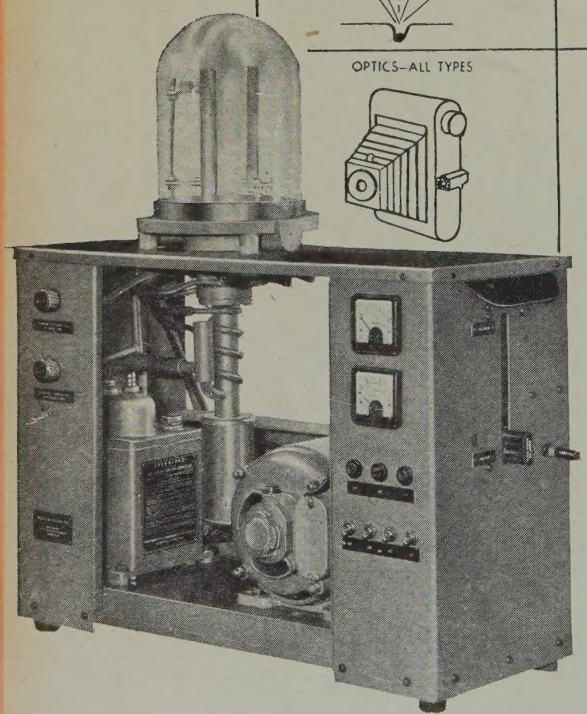

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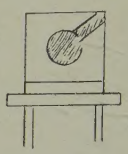

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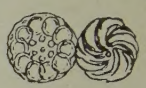

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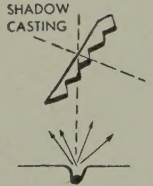

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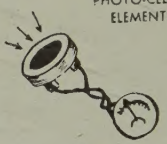

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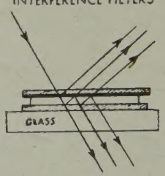

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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

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Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list, together with the lists published in the preceding issues of the current volume, supplements the List of Journals published with the January number of Volume 53 (1950) and the Supplements published with the Indexes to Volume 53 (1950) and Volume 54 (1951). Reprints of the List of Journals (1950) and the Supplements (1950, 1951) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for error.

Journals marked * are not received regularly.

Angew. Chem.	*Angewandte Chemie.* Verlag Chemie, Weinheim/Bergstr. 17(*a*).
J. Glaciol.	*Journal of Glaciology.* British Glaciological Society, c/o Royal Geographical Society, Kensington Gore, London, S.W.7.
J. Inst. Elect. Commun. Engrs. Japan	*Journal of the Institute of Electrical Communication Engineers of Japan.* Nagasaki Building, 2–8 Fujimicho, Chiyoda-ku, Tokyo.
Mem. Inst. Sci. Industr. Res. Osaka Univ.	*Memoirs of the Institute of Scientific and Industrial Research,* Osaka University. Kitashanada-cho 555, Sakai, Osaka.
**Mineral. Mag.*	*Mineralogical Magazine.* Oxford University Press, Amen House, Warwick Square, London, E.C.4.
New Zealand Engng.	*New Zealand Engineering.* New Zealand Institution of Engineers, 18, Aurora Terrace, Wellington, C 1.
Rep. Res. Inst. Elect. Commun. Tôhoku Univ.	*Reports of the Research Institute of Electrical Communication of Tôhoku University.* [A section of *Science Reports of the Research Institutes Tôhoku University, Series B (Technology).*] Tôhoku University, Sendai.

New Journals

Applic. and Industr.	*Applications and Industry.* Part 2 of *Transactions of the American Institute of Electrical Engineers.* 33, West 39th Street, New York 18. No. 1 dated *July,* 1952.
Commun. and Electronics.	*Communication and Electronics.* Part 1 of *Transactions of the American Institute of Electrical Engineers,* 33, West 39th Street, New York 18. No. 1 dated *July,* 1952.
Pwr. Apparatus and Syst.	*Power Apparatus and Systems.* Part 3 of *Transactions of the American Institute of Electrical Engineers.* 33, West 39th Street, New York 18. No. 1 dated *August,* 1952. Published bimonthly. Annual subscription for each publication $5 (plus 50c. foreign postage).
Rev. Mexicana Fis.	*Revista Mexicana da Fisica.* Instituto da Fisica, Tacubo No. 5, Mexico 1, D.F. [Provisional address.] Vol. 1, No. 1, dated *April,* 1952.

Change of Title

Proc. Amer. Pwr Conf.	*Proceedings of the American Power Conference.* Formerly *Proceedings of the Midwest Power Conference.*
Proc. Midwest Pwr Conf.	*Proceedings of the Midwest Power Conference.* Change of title to *Proceedings of the American Power Conference.*

Errata

Author Index (1950), p. 1142, column 2, line 60; *for* MONTROL, E. W. *read* MONTROLL, E. W.
P. 611 (1952), column 2, line 5: for *Abstr.* 5477–81 read *Abstr.* 5477–8.
Abstr. 251 (1952), line 2: *for* J. M. T. VIDAL *read* J. M. THARRATS VIDAL.
Abstr. 5708 (1952), line 2: *for* M. B. VOLKENSHTEIN *read* M. V. VOLKENSHTEIN.
Abstr. 6232 (1952), line 4: *for* F. C. REED *read* E. C. READ.
Abstr. 6751 (1952), line 3: *for* H. F. STODDARD *read* H. F. STODDART.
Abstr. 7679 (1952), line 10: for $L\delta\frac{1}{2}$ read $L\delta\frac{1}{2}$.
Abstr. 7696 (1952), line 12: *for* 61.5Å *read* 6·15Å.
Abstr. 8473 (1952), line 5: for $U°$ read $V°$.

Corrections to Articles

Corrections have been published, as shown below, to the articles whose Abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 8881 (1951): **20,** 1498 (*Sept.,* 1952).
Abstr. 1329 (1952): **23,** 420 (*Aug.,* 1952).
Abstr. 7287 (1952): **65,** 742 (*Sept.,* 1952).

512.9

7865. The relation of Eddington's E-numbers to the tensor calculus. I. The matrix form of E-numbers. S. R. MILNER. *Proc. Roy. Soc. A*, **214**, 292–311 (*Sept.* 23, 1952).

An E-number is an unusual mathematical form, constructed from sixteen algebraic variables and sixteen E-symbols (square roots of -1 obeying a non-commutative algebra), which has distinctive properties different from those of the square matrix of the variables employed in tensor theory. When the latter is considered to be a tensor, the corresponding E-number cannot be a standard tensor, and tensor calculus has made no use of it. Without loss of generality the E-symbols can always be envisaged as transforms of a certain set of numerical matrices, and it is shown here that when this is done every E-number can be expressed in a simplest form, called an $\mathscr{E}$-number. The reduction of an E- to an $\mathscr{E}$-number takes the form of a transformation analogous to that by which a physical magnitude is expressed in a different unit, the variables and the symbols being transformed oppositely. When evaluated the $\mathscr{E}$-number shows itself as a square matrix, which is characterized by having the data expressed by the sixteen variables arranged in another systematic way than that employed in the standard matrix of the variables. It may be obtained from this by a novel kind of transposition, in which the transposed elements are not the matrix terms themselves, but the symmetric and anti-symmetric parts of the terms. Alternatively, it may be obtained by submitting the standard matrix of the variables to a special type of transformation. The transformations employed in these operations differ from those normally used in matrix theory, as they take the form of sums of sets of matrix transformations. General formulae for the products of $\mathscr{E}$-numbers are derived. A.

512.9

7866. The relation of Eddington's E-numbers to the tensor calculus. II. An extension of tensor transformation theory. S. R. MILNER. *Proc. Roy. Soc., A*, **214**, 312–29 (*Sept.* 23, 1952).

When a square matrix is submitted to a tensor transformation (which is here expressed in matrix product form), the $\mathscr{E}$-number of the matrix undergoes a modification of the summed matrix product kind derived in Pt I. This modification, although it is quite different from a standard tensor transformation, satisfies the general conditions which characterize tensor transformations, and it follows that the $\mathscr{E}$-number of a standard tensor constitutes a new kind of tensor which requires to be taken into account in a complete tensor theory. The nature of the difference between the standard and the corresponding $\mathscr{E}$-number transformation is studied by examining the case of a rotation of the tensor concept in the 4-space in which it may be represented as existing. The $\mathscr{E}$-number transformation, while it also expresses rotation, is quite different both in amount and kind from the rotation of the tensor. When the standard tensor denotes an "orthogonal vector system"—a set of four equal mutually perpendicular vectors oriented together at a point like local axes—the $\mathscr{E}$-number system denotes two vectors having different determinate orientations; as the vector system is rotated as a whole to an arbitrary orientation, the two vectors of the $\mathscr{E}$-number undergo rotations which can turn them independently to different directions in the 4-space. Such behaviour is quite outside the scope of the standard tensor theory, and the extension which is necessary to include in it the new class of tensors is discussed. A.

513.77

7867. Transformation functions in the complex domain. G. IWATA. *Progr. Theor. Phys.*, **6**, 524–8 (*July–Aug.*, 1951).

If transformation functions in the complex domain are considered, they represent clear features that could not be expected in the real domain. A.

517.5

7868. Hypergeometric and Legendre functions with applications to integral equations of potential theory. C. SNOW. *Nat. Bur. Stand., Appl. Math. Ser., No.* 19, 427 *pp.* (1952).

The title hardly describes the wealth of information given in the book on these functions and the various methods of dealing with problems of potential theory. It begins with an outline of the theory of the functions and a very extensive list of formulae, transformations and analytic continuations. A generalization to Heun's function is mentioned: this satisfies a 2nd-order equation with 4 singular points, i.e. one more than the hypergeometric equation. There follows a detailed examination of integral representations with special reference to the cylinder functions and the kernels of certain integral equations, where boundary conditions are imposed on surfaces of revolution, but there is no axial symmetry in the solutions. This part serves as a basis for a large number of applications to problems using generalized co-ordinates of various types. In this second edition there is a chapter on the confluent hypergeometric function.

G. J. KYNCH

517.512.2

7869. On problems arising from graphical analysis by calculus methods. M. LEVY. *Canad. J. Phys.*, **30**, 147–58 (*March*, 1952) *In French.*

A re-examination of pass-band analysis reveals that the continuous and discontinuous treatments can be simply related and reconciled provided certain rules are obeyed, and that the solution is the same whatever the method used. A. J. KENNEDY

517.6 : 532.7

7870. Note on the linearized integral equation of Green. H. I. SCOINS. Letter in *Phil. Mag.*, **43**, 806–8 (*July*, 1952).

Using the superposition approximation with an averaging process, which introduces the parameter ε,

Green [Abstr. 1147 (1947)] has established an approximation to the radial function in a fluid of spherically symmetric molecules in the form

$$g(r) = \exp\{-\phi(r)/\kappa T\}|1 + f(r)| \text{ where } r[f(r) + \varepsilon\alpha(r)] = 1/(2\pi)^{\frac{1}{2}} \int_{-}^{+\infty} \varepsilon u\beta(u) \sin ru|(1-\sigma\beta(u).$$

It is now pointed out that Green's method of evaluating the integral in the second of the above equalities, when the denominator has zeros on the real axis is incorrect, and that the correct solution of the linearized integral equation leads to an asymptotic form for the distribution function which may well be a characteristic of the liquid state. J. S. G. THOMAS

517.78

7871. An approximate symbolic correspondence. M. COTTE. *C.R. Acad. Sci.* [*Paris*] **235,** 134–6 (*July* 16, 1952) *In French.*

In searching for a function whose Laplace transform was of a certain type, involving Hankel functions, it was found by using the asymptotic form of the Hankel functions, the result could be obtained in terms of the integral of the Gaussian error function. An upper limit is given for the inaccuracy caused by the approximation. N. CORCORAN

518.3 : 621.3.012.3

7872. The Multinomogram. A. LENNARTZ. *Funk u. Ton,* **6,** 242–6 (*May,* 1952) *In German.*

Describes a method of representing functions of several variables by combinations of nomograms, the relation between them being indicated by branching connecting lines. W. G. STRIPP (R.)

518.5 : 621.317.79 : 621.392.5

7873. On a new principle of construction of electrical machines for finding the roots of algebraic equations. D. MITROVIC. *C.R. Acad. Sci.* [*Paris*] **234,** 2519–21 (*June* 23, 1952) *In French.*

A ladder network is described consisting of equal constant impedances, equal variable impedances and variable sources of e.m.f. The e.m.f.s are shown to be simple functions of the coefficients of the given equation and the roots are obtained as the ratios of the variable to the fixed impedances when no current flows in the first loop of the ladder. Further details in *Ann. Fac. Sci. Toulouse,* **16** (1952). R. H. DAVIES

519.2 : 538.566.2 : 621.396.11

Fundamentals of probability theory. *See Abstr.* 8350

519.2 : 621.392.52

7874. The theory of prediction and filtering of stationary random series [séries aléatoires], after Norbert Weiner. I. H. JACOT. *Ann. Télécommun.,* **7,** 241–9 (*May,* 1952) *In French.*

Pt I of a résumé of the relevant chapters of *Extrapolation, interpolation and smoothing of stationary time series* by N. Wiener, together with a mathematical introduction. The properties of stationary random functions are discussed and the problem is enunciated in terms of the correlation function. Some properties of the operational calculus and of Fourier series and transforms are recalled, together with the generalization of harmonic analysis to cover the case of functions not related to a time origin. G. D. SIMS

519.2 : 621.392.52

7875. The theory of prediction and filtering of stationary random series [séries aléatoires], after Norbert Weiner. II. H. JACOT. *Ann. Télécommun.,* **7,** 297–303 (*June,* 1952) *In French.*

If $f(t-\tau) + g(t-\tau)$, the mean value of message + noise at time $(t-\tau)$ is known for $0 < \tau < \infty$ the most probable value of $f(t+\alpha)$ can be expressed as $\int_0^\infty [f(t-\tau) + g(t-\tau)]dK(\tau)$ where the function $K(\tau)$ is determined from the condition that the mean square error ε_N, must be a minimum. $K(\tau)$ satisfies a Wiener–Hopf equation, $h(\alpha+\tau) - \int_0^\infty \phi(\tau-\sigma)dK(\sigma) = 0$ in which $h(\alpha+\tau) = \phi_{11}(\alpha+\tau) + \phi_{12}(\alpha+\tau)$ and $\phi(\tau-\sigma) = \phi_{11}(\tau-\sigma) + \phi_{12}(\tau-\sigma) + \phi_{12}^*(\sigma-\tau) + \phi_{22}(\tau-\sigma)$, ϕ_{11} and ϕ_{22} being the self-correlation functions of message and noise respectively and ϕ_{12}, the intercorrelation function. This equation is solvable in terms of generalized Fourier transforms subject to certain restrictions on Φ, the transform of ϕ. ε_N is then calculated to be $\frac{1}{2\pi}\int_{-\infty}^{\infty} [\Phi_{11}(\omega)\Phi_{22}(\omega) - |\Phi_{12}(\omega)|^2/\Phi_{11}(\omega) + \Phi_{12}(\omega) + \Phi_{12}^*(\omega) + \Phi_{22}(\omega)]d\omega$.

G. D. SIMS

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.61 : 523.854

7876. Direct photography of the centre of the Milky Way in the near infrared. J. DUFAY, J.-H. BIGAY AND P. BERTHIER. *C.R. Acad. Sci.* [*Paris*] **235,** 120–2 (*July* 16, 1952) *In French.*

Photography with a Schmidt camera working at f. 1·8 on Eastman hypersensitized I–N plates, effective sensitivity band, 8000–8900 Å, has recorded a cloud-like area of very bright i.r. emission near the centre of the Galaxy, previously only detectable by the use of electronic image-converters. It is thought that on large-scale photographs the cloud will be resolved into discrete stars. D. R. BARBER

523.11 : 539.17

7877. The polyneutron theory of the origin of the elements. R. E. PEIERLS, K. S. SINGWI AND D. WROE. *Phys. Rev.,* **87,** 46–50 (*July* 1, 1952).

Assuming as an early stage in the expansion of the universe a homogeneous fluid of nuclear density and low temperature, it is shown that, for reasonable values of the constants, this will, on expansion, leave the matter in the form of droplets of the same properties

as those found in the Mayer–Teller "polyneutron" theory. However, this model leads necessarily to an abundance curve in which the amount of heavy elements is at least comparable to that of the light elements, contrary to experience. A.

523.12 : 536.7

7878. Boltzmann's fluctuation hypothesis. Ya. P. Terletskiĭ. Letter in *Zh. Eksper. Teor. Fiz.*, **22**, 506–7 (*No.* 4, 1952) *In Russian.*

For an ideal gas the relative magnitude of the fluctuations tends towards zero for an infinite number of particles, so that the probability of considerable fluctuations tends to vanish. All thermodynamical systems comparable with an ideal gas underlie this law. However, sections of the universe of galactic dimensions in which gravitational interaction between the particles exist, cannot be compared with an ideal gas, and the calculation of the probability of fluctuations shows that with increasing particle number this probability does not tend towards the limit zero. The universe is therefore more similar to a system in the critical state and no considerable section of it is ever in a condition comparable with thermodynamical equilibrium. The entropy of sufficiently large sections of the universe may, consequently, either increase or decrease, according to the conditions of the surroundings and to the history of the development and decay of the individual states. The matter of the universe is not in a unidirectional transition to more balanced states, but in cycles between more and less balanced or "probable" states. B. F. KRAUS

523.161

7879. Molecules of gas and grains of dust in interstellar space. C. S. Beals. *J. Roy. Astron. Soc. Can.*, **46**, 41–56 (*March–April*, 1952).

A summary of the experimental data on interstellar matter. M. W. OVENDEN

523.161

7880. The material of interstellar grains. A. Güttler. *Z. Astrophys.*, **31**, 1–25 (*No.* 1, 1952) *In German.*

From a theoretical study of the scattering properties of various types of particles over a range of sizes, in relation to the observed absorption effects produced by interstellar matter, it is concluded that it is not possible from the observations to decide whether or not the interstellar "grains" are essentially dielectric, or metallic. D. R. BARBER

523.161 : 523.854

7881. The space distribution of interstellar material in the Milky Way. L. Binnendijk. *Astrophys. J.*, **115**, 428–58 (*May*, 1952).

Several catalogues of interstellar intensities of the H and K doublet of Ca II, the D1 and D2 doublet of Na I, and the λ 4430 band were reduced to one system of equivalent widths expressed in Ångström units. Probable errors were determined from the external agreement, and the results are very close to the internal probable errors. The photoelectric colours of Stebbins, Huffer and Whitford and the Yerkes spectral classification were used to derive the interstellar reddening, corrected for zero point. The Morgan system was adopted for the spectroscopic distances of the B stars. The observed doublet ratios were studied in some detail, and curves of growth were derived in the usual way by shifting line segments. Small areas in the Milky Way were chosen, and the distance relations were established for the intensities, reddening and polarization. The galactic-rotation effect in the equivalent widths was found to be small, at least within a distance of $1 \cdot 8$ kpc. The average density of Ca II and Na I in successive distance intervals of 100 psc in each area was found with the help of the distance relations and the curves of growth. Figures were plotted, giving the average distribution of the gas and the smoke (or solid particles) in the plane of the Milky Way. Within a radius of 1 kpc in the plane, average numbers of 3×10^{-9} Ca ions and 11×10^{-9} Na atoms/cm^3 were found; the numbers for the continuum and the gas concentrations were $0 \cdot 8 \times 10^{-9}$ and 6×10^{-9} for Ca and 2×10^{-9} and 32×10^{-9} for Na, respectively. An indication was found of some structure, especially in the general direction of Cygnus, 90° from the direction of the centre of the Milky Way. The general relations between interstellar-line intensities and reddening for successive distance intervals of 300 psc were discussed for all observed stars in the Milky Way having accurate data. For unreddened stars the K and D intensities continue to increase for more distance intervals. It is found that for small areas the near-by stars and the distant stars give two almost parallel relations. The line intensity is a function both of the distance of the star and of the reddening; the first approximation yields $K = 0 \cdot 18\, r + 0 \cdot 7\, E_{1C}$. Reasons are given for the poor relations found by some authors. The relation between the λ 4430 band and the reddening is a simple one and holds for all distance intervals. The interpretation of observations of interstellar material is intermediate between the uniform distribution and the other extreme, namely, all gas and smoke concentrated in discrete clouds. In general, the clouds consist of gas and smoke (or solid particles); between the smoke clouds a rarefied gas continuum is still observable, but the smoke continuum is either still more rarefied or cannot be observed. Reasons are given why in some places deviations may occur from this general behaviour. The Ca and Na gases seem to be well mixed. They indicate the galactic-rotation effect; they show small-scale turbulence effects; and in some places larger-scale currents introduce the multiplicity of the interstellar lines. No decisive result could be found as to whether there is a flow of the gas out of the Milky Way. A.

523.165

7882. Electromagnetic radiation of cosmic-ray protons and galactic radio emission. A. A. Korchak and Ya. P. Terletskiĭ. Letter in *Zh. Eksper. Teor. Fiz.*, **22**, 507–9 (*No.* 4, 1952) *In Russian.*

On entering magnetic fields of $\sim 10^{-4} - 10^{-5}$ gauss, cosmic-ray protons with the known power law energy spectrum would radiate with a power law frequency spectrum whose exponent is consistent with observations on galactic radio emission. To obtain the observed intensity with some reasonable average cosmic-ray flux, volumes $\sim 10^9$ times the Galaxy would be needed. This points to the existence of localized sources. W. J. SWIATECKI

523.165 : 523.854

7883. Measurements of radiation from the Milky Way on 255 Mc/s. I. ATANASIJEVIĆ. *C.R. Acad. Sci.* [*Paris*] **235,** 130–2 (*July* 16, 1952) *In French.*

Preliminary report of a radio-survey of the Galaxy. Using a band-pass width of 1 Mc/s, measures of radio intensity at 255 Mc/s have been made at Meudon with an antenna of 7·5 m dia. A chart of provisional isophotes is included. D. R. BARBER

523.165 : 537.591

7884. On the possible relation of galactic radio noise to cosmic rays. G. W. HUTCHINSON. *Phil. Mag.*, **43,** 847–52 (*Aug.*, 1952).

The possibility is considered that cosmic rays are accelerated in regions of the Galaxy of intermediate particle density ($\simeq 10^9$ cm^{-3}). It is found that a conservative estimate of the magnetic fields in such regions would lead to a radio noise flux of the observed order of magnitude, and that the observed spectrum could easily be produced. A possible cause is suggested for the low energy cut-off in the cosmic-ray spectrum. If the proposed mechanism accounts for any large proportion of the cosmic rays, these should be accompanied by a small flux of γ-quanta which should show the same anisotropy as the galactic radio noise. A.

523.4

7885. The origin of the solar system (Bakerian Lecture). H. JEFFREYS. *Proc. Roy. Soc. A*, **214,** 281–91 (*Sept.* 23, 1952).

Some of the principal theories of the origin of the planets and satellites are discussed. The principal topics are the nebular theory (Roche's form), tidal theories, collision theories; disk theories; densities of the planets; fission theories of the origin of the moon; origin of small bodies; initial temperatures; constitutions of the planets; the moon's surface features. A.

523.51

7886. Reflection from meteoritic surfaces. F. A. KLOVERSTROM AND W. A. RENSE. *Astrophys. J.*, **115,** 495–500 (*May*, 1952).

Observational data are presented pertaining to the polarization of light diffusely reflected by several meteoritic samples. Comparison of results with theory indicates that the polarization may be explained by a combination of molecular-like scattering and metallic-like reflection, even in the case of stony meteorites. Directional and total albedos for the samples are also listed. A.

523.59

7887. The origin of zodiacal light. W. A. RENSE. *Astrophys. J.*, **115,** 501–5 (*May*, 1952).

On the assumption that the zodiacal glow is caused by reflection from stony and metallic particles which make up an interplanetary cloud whose density falls off inversely with distance from the sun, predicted values of polarization and intensity variations along the glow are made. Diffuse-reflection studies of laboratory specimens of meteoritic surfaces were utilized. The results compare favourably with available observations of the glow. A.

523.72

7888. Thermal emission from the solar corona in the centimetre-metre wavelength range. A. REULE. *Z. Naturforsch.*, **7a,** 234–47 (*March–April*, 1952) *In German.*

A mathematical discussion of the intensity-distribution of thermal radiation with λ for a series of isothermal corona models. Intensity calculations take into account effects of refraction, and density variation. The influence of the coronal streamers on the intensity-pattern is also examined, and it is shown that marked departures from radial symmetry can lead to false interpretation of the results. D. R. BARBER

523.746

7889. The visibility-function of sunspots. M. ROGGENHAUSEN. *Z. Astrophys.*, **30,** 249–60 (*No.* 4, 1952) *In German.*

A statistical analysis of the dependence of the visibility of sunspot groups on angular distance from the solar centre is made. The data are divided into sunspot groups with known sunspot numbers, and groups of a definite type on Brunner's classification. M. W. OVENDEN

523.746

7890. Prominence activity and the sunspot cycle. R. ANANTHAKRISHNAN. Letter in *Nature* [*Lond.*] **170,** 156–8 (*July* 26, 1952).

Photographic observations of *K*-line prominence activity made at Kodaikanal, India, 1905–50, are compared with relative sunspot numbers for the 4 concurrent cycles; and isopletes of mean daily prominence activity for each 5 zone of N- and S-solar hemispheres separately are depicted graphically. The region of most intense activity occurs at *c.* lat. 50°–55° in both hemispheres some 3 or 4 yr before spot max. D. R. BARBER

523.75

7891. Sunspot prominences and the yellow coronal line. W. O. ROBERTS. *Astrophys. J.*, **115,** 488–94 (*May*, 1952).

A study of twenty-five cases of bright emission of the yellow coronal line λ5694, from 1946 through 1951 revealed close association between this emission and fast-moving prominences of the "sunspot" type. It also showed that unusually sharp discontinuities and intensifications of the red coronal line λ6374 occurred at the regions where the yellow coronal line was seen. In a few cases small Doppler effects in λ6374 also appeared at the solar-limb position of the λ5694 emission. The observations lead to the preliminary speculation that the source of the emission corona lies in a few, relatively small, active regions scattered over the solar disk. A.

523.75

7892. Basic types of motion in solar protuberances. A. B. SEVERNYĬ. *Dokl. Akad. Nauk SSSR*, **82,** 25–8 (*No.* 1, 1952) *In Russian.*

The article summarizes the chief results of research on this subject by cinematic registration from 1948 to 1950–1. Three basic types of motion, eruptive, electromagnetic and turbulent, were identified as governing forms of protuberance. These types are illustrated by diagrams showing characteristic courses of trajectories, speeds in relation to height, and lengths of trajectory arcs as functions of the time. Photographs of three typical forms of protuberance under the three headings are reproduced. J. CLEUGH

523.755 : 537.568

7893. Ionization and recombination processes in a plasma, and the ionization formula for the solar corona. G. ELWERT. *Z. Naturforsch.*, **7a**, 432–9 (*June*, 1952) *In German.*

The fundamental processes of ionization, and recombination are critically examined in the case of matter not in thermal equilibrium. A rigorous ionization formula is developed, and applied to the derivation of coronal temperatures corresponding to values of the line intensity ratio (I_{5303}/I_{6374}), 0·05 to 20, which lie within the range of observational interest. D. R. BARBER

523.77

7894. Visual photometry of the prominence emissions $b_1 - b_4$. R. MÜLLER. *Z. Astrophys.*, **30**, 293–8 (*No.* 4, 1952) *In German.*

The intensities of the Mg triplet (lines b_1, b_2, b_4) and the variable Fe II line (b_3) were measured in absolute units, and the intensity ratios between b_3 and b_4 obtained. These ratios, together with the assumption of an electron density of 10^{11} cm^{-3}, yield an electron temperature $\sim 4300°$ for a typical prominence. M. W. OVENDEN

523.77

7895. Interpretation of the calcium and hydrogen spectroheliograms. E. R. MUSTEL. *Dokl. Akad. Nauk SSSR*, **82**, 21–4 (*No.* 1, 1952) *In Russian.*

Comparison of the calculated ratio of the numbers of captures with the results of observation shows that the emission of the *K*-line in flares is determined by collisions of Ca II atoms with electrons. Further analysis shows that (1) Ca flares are grouped in the lower layers of the chromosphere where the turbulence is small, and (2) the temperature $T_{kin} = 7500°$ is wholly sufficient for causing an emission in the K_2 and H_2 lines. In the case of the Balmer line H_α, collisions with electrons play a role comparable to that of recombinations. F. LACHMAN

523.841

7896. Similarity between solar phenomena and variability of stars in gaseous nebulae. H.-J. BINGE. *Z. Naturforsch.*, **7a**, 440–4 (*June*, 1952) *In German.*

An analysis of the light-curves of certain RW Aurigae variable stars points to their resemblance to the sun, and suggests a mechanism analagous to solar spot activity which will explain their variability. D. R. BARBER

523.841 : 523.854

7897. Variable stars and galactic structure. C. PAYNE-GAPOSCHKIN. *Nature* [*Lond.*] **170**, 223–5 (*Aug.* 9, 1952).

A synopsis of 3 lectures given in the University of London, May, 5, 7, 8, 1952, in which the physical properties, galactic distribution and spatial motion of the intrinsic variable stars (as distinct from the geometrical, eclipsing binaries) are reviewed in the light of recent work, and in relation to the complex structure of the central galactic layer. D. R. BARBER

523.842

7898. Mean distances in single-line binaries. V. M. BLANCO. *Astrophys. J.*, **115**, 423–7 (*May*, 1952).

The distribution of mean distances is determined for a group of single-line spectroscopic binaries with primaries within the spectral-type interval B8–A5. The masses of the primaries are evaluated from the mass-luminosity relation, and the distribution of mass ratios is obtained from the mass functions by assuming random inclinations. The distribution of mass ratios and Kepler's third law are then used to determine the distribution of mean distances. The effects of incompleteness of the observational data are allowed for. The systems studied show a marked drop in number with decreasing mean distances at $a = 7 \times 10^6$ km. The frequency of mass ratios is found to increase with decreasing mass ratios. A.

523.852.21

7899. Dynamics of the diffuse nebulae. A. I. LEBEDINSKIĬ. *Dokl. Akad. Nauk SSSR*, **84**, 249–52 (*No.* 2, 1952) *In Russian.*

The thickness of the stratum of diffuse matter in the various galaxies is of the order of hundreds of parsecs; this stratum is inhomogeneous and consists of individual nebulae of irregular shape and cross-sections of the order of 10 parsec. An approximate energy balance, based on dynamical analysis of the possible types of collision processes shows that diffuse matter can only be distributed in the form of more or less irregular nebulae; also, these nebulae must be of a size at least one order of magnitude smaller than stellar clouds, which agrees with observed facts. B. F. KRAUS

523.854

7900. Determination of the mass of the Galaxy from [observations of] the radial velocities of globular clusters. W. LOHMANN. *Z. Astrophys.*, **30**, 305–6 (*No.* 4, 1952) *In German.*

From obsns. of 21 clusters, a mean value of $2{\cdot}1 \times 10^{11} M_\odot$ is obtained, and this result, when combined with a previous value for 4 clusters, gives a final mean for clusters having a distance from galactic centre > 10 kpc. $M = 1{\cdot}9 \times 10^{11} M_\odot$ for the mass of the Galaxy, with an uncertainty of *c.* 10%. D. R. BARBER

523.872

7901. Spectroscopic evidence of molecular hydrogen in the atmospheres of Uranus and Neptune. G. HERZBERG. *Astrophys. J.*, **115**, 337–40 (*May*, 1952).

The unidentified diffuse feature at 8270 Å observed by Kuiper in the spectra of Uranus and Neptune is reproduced in the laboratory in an 80 meter path of H at 100 atm pressure and a temperature of 78°K. It is the *S*(0) line of the 3–0 pressure-induced rotation-vibration band of the H_2 molecule. Two other lines of this band, as well as three lines of a double transition (2–0, 1–0), are observed in the laboratory spectrum. Most of these features are hidden in the planetary spectra by strong CH_4 bands, but a line, 8166 Å, of the double transition is only partially overlapped by an adjacent CH_4 band. Its low intensity in the planetary spectra can be accounted for by assuming that there are even larger amounts of He than of H in the atmospheres of Uranus and Neptune. He does not induce the double transition. The observed spectra are very roughly compatible with a 3 : 1 (or higher) He–H ratio, a temperature of 78°K (or lower), and a partial pressure of H at the bottom of the visible atmosphere of about 2 atm. The thickness of an equivalent atmosphere of uniform density would be about 18 km for Uranus. A.

523.872

7902. On the distribution of energy in the continuous spectra of stars of early spectral types. D. CHALONGE, P. GUÉRIN AND S. TAFFARA. *C.R. Acad. Sci.* [*Paris*] **235,** 124–6 (*July* 16, 1952) *In French.*

Relative gradient measures over the region 3800–6500 Å give a linear relation between $\log (I/I')_\lambda$ and $1/\lambda$ when comparing stars of types earlier than B5 with types O B and early A, but this line is broken at about 4800 Å when comparisons are with later A and F type stars, with different gradients on either side of the break. Absolute measures, with lab. comparison show this to be due to departure from black-body distribution in early type stars, with change of gradient at 4800 Å, while F stars show no appreciable departure. D. L. EDWARDS

523.872

7903. The absolute energy distribution in stellar radiation from 4 000 to 10 000 Å and the determination of effective temperatures. K. PILOWSKI. *Z. Astrophys.*, **31,** 26–47 (*No.* 1, 1952) *In German.*

From an exptl. determination of absolute energy distribution in the spectra of 30 stars, spectral classes A–M, of different stellar types it is found that although the departure from "black-body" distribution is independent of stellar character for stars of classes A to F, depressions are found at 5100 Å for the K-stars, and at 5100, 5900 and 6300 Å for the M-stars. A peculiarity in u.v. energy distribution serves to distinguish the sub-dwarfs from the remaining stars. Energy distribution in i.r. is such that departure of observed distribution from "black-body" radiation becomes inappreciable for temperatures *c.* 8000°. For temperatures $\leqslant 8000°$, radiation and effective temps. agree, whilst for temperatures $> 8000°$ the effective temp. is *c.* 10% lower. D. R. BARBER

523.872

7904. A magnetically-conditioned polarization effect in the resonance lines of a stellar spectrum. I. G. THIESSEN. *Z. Astrophys.*, **30,** 307–17 (*No.* 4, 1952) *In German.*

On observing the integrated light from a star possessing a dipole magnetic field, in a direction $\perp$ to the dipole axis, polarization of the resonance radiation will appear with max. electric vector || to the direction of observation. For Ca line 4227 Å (and for Balmer series of H), degree of polarization will be given by the quantity, $0{\cdot}06\,\sigma/\chi$, where σ is limb scattering coeff. and χ is continuous absorption coeff. Taking $\sigma/\chi = 0{\cdot}15$, the observed polarization will be *c.* 1%, the direction of vibration of max. component being || to mag. dipole axis. D. R. BARBER

523.873

7905. The classification of some stellar groups. J. BERGER. *C.R. Acad. Sci.* [*Paris*] **235,** 234–6 (*July* 21, 1952) *In French.*

Based on Chalonge and Divan's graphical method of stellar classification [Abstr. 7005 (1952)] work has been extended to (*a*) selected stars of the Pleiades system, (*b*) certain metallic-line stars and (*c*) a group of sub-dwarf stars. Similar investigations are in course for the Hyades system, and the Perseus cluster. The results to date are displayed on a D–λ_1 diagram. D. R. BARBER

523.877

7906. On the curve-of-growth method. S.-S. HUANG. *Astrophys. J.*, **115,** 529–43 (*May*, 1952).

In the calculation of the theoretical curve of growth, physical parameters, such as the Doppler velocity, the damping constant, etc., are supposed to be constant for the entire atmosphere. Investigations have therefore been made in this paper to show, in the first place, what is the meaning, if any, of the values determined for such parameters by the curve of growth, when, as a matter of fact, all these parameters vary with depth in real stellar atmospheres; and, second, among many theoretical curves of growth so far computed by various authors, what particular one should be used in order to have the best approximation. For lines formed according to the mechanism of local thermodynamic equilibrium we conclude that the observationally determined value can be regarded as a certain mean value properly weighted according to the formula given in the present paper. And the theoretical curve of growth computed independently by Unsöld and by Menzel is one of the best for practical use. The temperature, the turbulent velocity and the damping constant in stellar atmospheres derived from the curve of growth are individually discussed in the light of the present analysis. The observationally determined values for these quantities are, on the whole, consistent with the predicted values as given by the proposed averaging formula. A.

523.877

7907. Superthermic phenomena in stellar atmospheres. VII. Collisional excitation from levels other than the lowest. S. MATSUSHIMA. *Astrophys. J.*, **115,** 544–9 (*May*, 1952).

For Pt VI, see Abstr. 57 (1951). The effect on the chromospheric b_n values of collisional excitation from other than the ground level is computed. The principal effect occurs in b_1 and b_2. The collisional terms place an upper limit on b_2 over the case where radiative terms only were included. The resulting prediction on the population of the Balmer ground state agrees well with the value inferred from eclipse observations. A.

523.877

7908. Superthermic phenomena in stellar atmospheres. VIII. Comment on the chromospheric model. R. N. THOMAS. *Astrophys. J.*, **115,** 550–61 (*May*, 1952).

The analytic structure for a model solar chromosphere in a statistically steady state is summarized. The dependence of the structure upon chromospheric eclipse observations is exhibited, and several checks upon the internal consistency of the model are discussed. A.

523.877

7909. On the radius of gyration of stars. L. MOTZ. *Astrophys. J.*, **115,** 562–6 (*May*, 1952).

A comparison of the radius of gyration of a star, which is defined by the integral

$$H = \left(\frac{8\pi}{3M}\int_0^R \rho r^4 dr\right)^{1/2},$$

with the apsidal-motion constant for various stellar

models shows that, for polytropes and various main-sequence stars, there is a linear relationship between $-\log(H/R)$ and $-\log k$, where k is the apsidal-motion constant. Giant models, however, do not fall on this line. The apsidal-motion constant for the Epstein two-source (proton–proton reaction and the carbon cycle) model for the sun is found to be 0·00599, which is equivalent to an effective polytropic index of 3·38. This result is used to draw some conclusions concerning the point along the main sequence where the proton–proton process gives way to the carbon cycle. A.

523.877

7910. The variable magnetic field of stars. N. Stoyko. *C.R. Acad. Sci.* [*Paris*] **235,** 122–4 (*July* 16, 1952) *In French.*

From a previous investigation [Abstr. 9184 (1951), 6218 (1952)] it was found that the varying magnetic field possessed by a body in non-uniform rotation will have an intensity proportional to the rate of change of rotational velocity. The theory is applied to the sun, and to certain other stars whose magnetic fields are known to vary in intensity. It is demonstrated that, for the latter, the observed large-scale changes in field-strength may be explained solely as the result of variations of their periods of rotation, amounting to *c.* 1%. D. R. BARBER

525.35

7911. Numerical study of the secular movement of the terrestrial axis. H. Berthod-Zaborowski, M. Mayot and H. Mineur. *C.R. Acad. Sci.* [*Paris*] **235,** 232–4 (*July* 21, 1952) *In French.*

Using numerical integration, values of ε', the obliquity of the ecliptic, have been computed over a period of $\pm 150\,000$ yr taking 1900·0 as zero epoch. The curve of fluctuation, though not strictly periodic, shows successive max. and min. values of ε' (tabulated) which fit a period of *c.* 43 000 yr. During the entire period considered, the obliquity variation exhibits an amplitude range of from 22° 9′ 33″ to 24° 27′ 2″, and the precessional constant varies between 50″·11 and 50″·90. D. R. BARBER

525.36

7912. A direct treatment of the Foucault pendulum. W. J. Noble. *Amer. J. Phys.*, **80,** 334–6 (*Sept.*, 1952).

The equations of motion of the Foucault pendulum are set up in polar co-ordinates. The oscillation is shown to be simple harmonic for a particular angular velocity, $-\Omega \sin\phi$, where Ω is the angular velocity of rotation of the earth and ϕ is the latitude. In general, the motion involves a constant areal velocity c and a non-linear oscillation given by $\ddot{r} + \omega^2 r - c^2/r^3 = 0$. This equation is integrated through the energy equation and shown to give the same precession as in the harmonic case. A.

525.6

7913. A determination of the frictional forces in a tidal current. K. F. Bowden and L. A. Fairbairn. *Proc. Roy. Soc. A,* **214,** 371–92 (*Sept.* 23, 1952).

These have been determined from simultaneous observations of the surface gradients and the currents at various depths. The observations were made a few miles from the coast, off Red Wharf Bay, Anglesey. The gradients were derived from measurements of the surface elevations obtained by a pair of open-sea tide-gauges of the Favé type, modified to give increased accuracy. The Doodson electrically recording current meter was used for the current measurements. Expressing the amplitude of the frictional force at the bottom in the form $F = k\rho U^2$, where U is the amplitude of the mean current from surface to bottom, and ρ is the density of the water, the results give the coefficient k an average value of $1{\cdot}8 \times 10^{-3}$. The internal frictional stress in the water was found to increase approximately linearly with depth from the surface to the bottom, and the corresponding values of the mean eddy viscosity have been derived. A.

529.781 : 621.396.11

7914. The delay caused in the propagation of hour signals on decametre waves. R.-P. Lejay and G. Pillet. *Ann. Franç. Chronom.*, **6,** 192–208 (*No.* 3, 1952) *In French.*

Considerations of the time-delay involved in the transmission of hour signals between stations. To obtain an accuracy $\geqslant 10^{-3}$ sec precise knowledge of the duration of transmission is necessary, involving discrimination between the different possible transmission paths, and elimination of causes of errors (e.g. lateral deviations). Methods applicable to very short distances (<100 km), medium and very great distances (>1500 km) are separately considered.

G. M. BROWN

PHYSICS 53

53 : 62

7915. Summarized proceedings of the Fourth Industrial Physics Conference—Glasgow, June 1952. W. R. Thomas. *Brit. J. Appl. Phys.*, **3,** 273–7 (*Sept.*, 1952).

Papers and discussions on "Physics in the transport, shipbuilding and engineering industries," summarized at about 300 words each. The subjects were: "Physics in the service of metallurgy" (A. McCance); "Meteorology in industry" (R. Watson-Watt); "The education and training of industrial physicists in Scotland" (J. Taylor); "Physics and sound reproduction" (D. T. N. Williamson); "Some applications of physics in naval architecture" (A. M. Robb); "Some applications of physics in transport" (M. G. Bennett, T. A. Eames); "Automatic control of industrial processes" (A. J. Young); "Noise and its suppression" (N. Fleming).

53.089 : 537.543 : 621.392 : 621.317.35

7916. A new method for investigating relaxation processes. I. P. Valkó and G. Gergely. *Acta. Phys. Hungarica,* **1,** 261–76 (*No.* 3, 1952).

A new compensating method was developed for the

investigation of relaxation phenomena governed by several exponential processes. The electric compensating pulse, consisting of a sum of exponentials, is produced by means of RC networks. Each of them controls a separate pentode, the pentodes having a common load resistance for adding the components. The method was applied to the investigation of the rise and decay phenomena of willemite luminescence. A.

53.089 : 621.317.79 : 621.317.785

7917. A simple device for finding the RMS value of recorded data. C. M. CRAIN AND M. F. HAINEY. Note in *Rev. Sci. Instrum.*, **23**, 243–5 (*May*, 1952).

The trace under examination is followed by the needle of a d.c. voltmeter, by the continuous manual adjustment of a potentiometer as the record is driven past the needle. The potentiometer is ganged to a variable transformer in an a.c. network which controls the current and voltage inputs to a standard watt-hour-meter. These inputs are always $\propto$ the instantaneous values of the original traces, thus the Wh-meter reading is $\propto$ the square of such values. A second Wh-meter records the average value of the trace. The use of this reading in adjusting for the true average value of the trace is explained. Tests with triangular and square waves showed errors to be ~5%. A. J. KENNEDY (R)

FUNDAMENTALS 530.1

530.12

7918. On solutions of new field equations of Einstein and those of Schrödinger. H. TAKENO, M. IKEDA AND S. ABE. *Progr. Theor. Phys.*, **6**, 837–48 (*Sept.–Oct.*, 1951).

Solutions of the field equations in these theories are searched for. Under the assumption of spherical symmetry, static solutions of their field equations are obtained, and it is shown that the exact solutions of Papapetrou are included in them. It is usually considered that affinity of the space-time is determined uniquely from the equation $g_{ij;k} = 0$ for a given g_{ij}, but it is not necessarily the case. This circumstance is made clear and some further investigations are made with respect to the necessary and sufficient condition that affinity can be determined uniquely. A.

530.12

7919. Relativity of representation coordinates and its consequences. G. IWATA. *Progr. Theor. Phys.*, **6**, 684–90 (*Sept.–Oct.*, 1951).

Relativity of space-time co-ordinates has been fully appreciated in theoretical physics. It seems to the author, however, that relativity of representation co-ordinates is not clearly acknowledged. Consequences of this relativity are briefly discussed. A.

530.12

7920. Quantization of Einstein's gravitational field: general treatment. S. N. GUPTA. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 608–19 (*Aug.*, 1952).

The quantization of the complete gravitational field is carried out by extending the work of an earlier paper [Abstr. 3267 (1952)]. The main obstacles in the quantization of Einstein's field are overcome by expressing the field quantities in the Riemannian space as expansions in the flat space, and then splitting the gravitational field into the linear and the non-linear parts. The linear part of the gravitational field is regarded as the free gravitational field, while the non-linearity is treated as a direct interaction between the gravitons. This treatment is quite general, but it suffers from the usual limitations of the perturbation method. The gravitational self-energies of the photon and the electron are also investigated by using the linear approximation of the gravitational field. It is found that the photon self-energy vanishes unambiguously, while the electron self-energy is quadratically divergent. A.

530.12 : 531.18

7921. Gardner's hypothesis and the Michelson–Morley experiment. J. L. SYNGE. Letter in *Nature* [*Lond.*] **170**, 243–4 (*Aug.* 9, 1952).

See Abstr. 6271 (1952).

530.12 : 531.18

7922. Rigid-body motions in special relativity. G. H. F. GARDNER. Letter in *Nature* [*Lond.*] **170**, 243 (*Aug.* 9, 1952).

A new definition of rigidity is stated [see Abstr. 6271 (1952)] and applied to the case of a rotating disk. R. A. NEWING

530.145

7923. Remarks on the applications of group theory to quantum physics. A. GAMBA. *Rev. Sci.* [*Paris*] **90**, 11–24 (*Jan.–Feb.*, 1952) *In French.*

A practical introduction to the theory of groups. The properties of group representations are outlined and exemplified by discussion of the rotation and permutation groups, which are then used to classify the atomic levels for n electrons in L–S coupling. The relation of selection rules to the properties of group representations is briefly explained. R. H. DALITZ

530.145

7924. Relativistic two-body problem in quantum theory. K. SAKUMA, N. SHÔNO AND T. OUCHI. *Progr. Theor. Phys.*, **6**, 748–61 (*Sept.–Oct.*, 1951).

A general method for treating the quantal two-body problem relativistically is developed on the lines of Dirac's many-time theory. The case where two charged fermions interact with each other through the electromagnetic field is investigated as an example. A canonical transformation is constructed which eliminates the electromagnetic field variables in the original Schrödinger equations, and the potential energy between two charged particles is derived. Finally, some properties of the simultaneous wave equations for the system of two particles are discussed, and a method for treating the stationary state of that system is indicated. A.

530.145

7925. A proposed re-interpretation of quantum mechanics. O. HALPERN. Letter in *Phys. Rev.*, **87**, 389 (*July* 15, 1952).

The similarity of the equation for S in Bohm's interpretation of quantum mechanics [Abstr. 2413–14 (1952)] to the Hamilton–Jacobi equation is insufficient to establish the possibility of a mechanical interpretation of quantum mechanics, since the solution

for S cannot contain f integration constants not present in the function R. R. H. DALITZ

530.145

7926. Reply to a criticism of a causal re-interpretation of the quantum theory. D. BOHM. Letter in *Phys. Rev.*, **87**, 389–90 (*July* 15, 1952).

Amplifies his proposed method of solution of the equations of his interpretation of quantum theory [Abstr. 2413–14 (1952)] in order to meet and discuss the objections of Halpern (preceding abstract). R. H. DALITZ

530.145

7927. Path concepts in Hamilton–Jacobi theory. R. LANDAUER. *Amer. J. Phys.*, **20**, 363–7 (*Sept.*, 1952).

It is pointed out that the classical analogue to a wave function is not a single orbit but a set of paths as defined by the solution of the Hamilton–Jacobi equation. A review is given of Hamilton–Jacobi theory in language appropriate to these path concepts. It is shown that there is a classical analogue to a wave packet. Quantum mechanically, constants of motion are not arbitrary but must be characteristic values of commuting operators. It is shown by examples that the possible classical states are similarly restricted. The conditions are discussed under which a classical set of paths is derivable from the solution of a Hamilton–Jacobi equation. A.

530.145

7928. Variational equations in quantum field theory. N. N. BOGOLYUBOV. *Dokl. Akad. Nauk SSSR*, **82**, 217–20 (*No.* 2, 1952) *In Russian.*

The consequences are investigated of replacing the discontinuous step function $g(x) = 1$ or 0, entering in the integral equation for the state vector Φ, by a smoothed-out function expressing a diffuseness in the localization of the time instant. A scheme is set up in which the proper values of the linear and angular momenta are unaffected and conditions for approximate localizability are given. The effect of a gauge transformation is written down. W. J. SWIATECKI

530.145

7929. On the invariant structure of the quantum field theory. II. V. L. BONCH-BRUEVICH AND B. V. MEDVEDEV. *Zh. Eksper. Teor. Fiz.*, **22**, 425–35 (*No.* 4, 1952) *In Russian.*

For Pt I, see Abstr. 2366 (1951). The four fundamental conditions of relativistic invariance, corpuscular aspect of the field, the Hamilton method, and complete localizability, are shown to be incompatible, except in cases that are physically insignificant. This holds not only for arbitrarily interacting scalar fields but also for non-scalar types. The requirement of invariance presumably involves more physical meaning than is usually attributed to it. J. JACOBS

530.145 : 536.7

7930. Quantum mechanics and thermodynamic continuity. A. LANDÉ. *Amer. J. Phys.*, **20**, 353–8 (*Sept.*, 1952).

The basic concepts and rules of quantum mechanics are shown to be immediate consequences, on the basis of simple reasoning, of a postulate of continuity in the domain of macroscopic thermodynamics. The continuity principle leads first to the concept of a fractional likeness between two states in general, as opposed to the classical alternative of either like or unlike. Then all possible states of a system can be arranged in sets of mutually unlike or "orthogonal" states, with members A and B of different sets interconnected by fractional likeness factors $q(A, B)$ between zero and unity. These factors q are identical with the relative intensities in a splitting effect of a state into components, ruled by probability relations and by the basic principle of quantum statistics of not counting permutations of individual particles. The problem of relation between the various fractional likenesses, or probabilities of transition under analysis, is a purely mathematical problem and is solved by the introduction of probability amplitudes necessarily subject to a matrix law of multiplication, i.e. to the principle of superposition. Thus, starting from the continuity postulate of thermodynamics, quantum theory in its general outline is obtained by simple reasoning. All further details, such as the duality of waves and particles, the uncertainty relation, and the mechanics of special systems need only one more bit of empirical information, namely, the symmetric and periodic form of the amplitude ψ of fractional likeness between a state of given co-ordinate and a state of given momentum. A.

530.145

7931. Spinors in the dynamical theory of spinning particles. S. SHANMUGADHASAN. *Canad. J. Phys.*, **30**, 226–34 (*May*, 1952).

The correspondence between self-dual six-vectors and symmetric spinors of the second rank is used to put into spinor form the rotational equations of motion of a particle analogous to a pure gyroscope or to a symmetrical top. These equations are then split up into an equivalent system of equations in terms of spinors of the first rank. The Lagrangian of each system is set up, and the canonically conjugate variables obtained from it in terms of covariant spinors. But the canonical variables, being not all independent, lead to weak equations in the sense of Dirac. Therefore, Dirac's generalized Hamiltonian dynamics is used in the canonical formulation in terms of Poisson Brackets. The detailed discussion of the symmetrical top case shows that, though the fundamental Poisson Brackets for the total spin angular momentum and the "spin" are the usual ones, those Poisson Brackets involving the derivative of the "spin" are not unique. A.

530.145

7932. On the hypothesis of a fundamental interval and the theories of Darling and Born. H. FREISTADT. *C.R. Acad. Sci.* [*Paris*] **235**, 23–5 (*July* 7, 1952) *In French.*

A new interpretation of the theory of Darling. The calculus of finite differences used, based on the notion of a fundamental length, is justified, and the corresponding spectrum of proper masses obtained. R. H. DALITZ

530.145

7933. The validity of Born expansions. W. KOHN. Letter in *Phys. Rev.*, **87**, 539 (*Aug.* 1, 1952).

Estimates of the radius of convergence of the Born expansions of $\tan \eta$ and of $\exp(2i\eta)$ in powers of the strength of the potential (central) are given as function

of energy and angular momentum. A number of other properties of Born expansions are also summarized. R. H. DALITZ

530.145

7934. The commutation laws of relativistic field theory. R. E. PEIERLS. *Proc. Roy. Soc. A*, **214**, 143–5 (*Aug.* 21, 1952).

A definition of Poisson brackets is given which is related to the action principle, but does not require the introduction of canonical variables. This permits the laws for forming both the commutators of canonical theory and the anticommutators of Fermi–Dirac particles to be stated in a manifestly covariant way. Examples of the use of this method are given. The last section discusses tentatively the extension to the case of equations which cannot be written in canonical form. A.

530.145

7935. Resonance in collision processes. O. OLDENBERG. *Phys. Rev.*, **87**, 786–9 (*Sept.* 1, 1952).

The limitations are investigated under which "resonance" provides certain collision processes with preferred probability. In impacts of the second kind, resonance strongly affects the transfer of electronic into electronic energy or into a small amount of vibrational energy, possibly the transfer of vibration into vibration, certainly not the transfer of vibration into rotation. Resonance is not effective in the transfer of energy of atomic recombination into electronic energy and, in general, resonance is not effective in processes in which nuclei change positions by appreciable amounts. A.

530.145

7936. Selection rules imposed by charge conjugation and charge symmetry. A. PAIS AND R. JOST. *Phys. Rev.*, **87**, 871–5 (*Sept.* 1, 1952).

It is found that the invariance with respect to charge conjugation and charge symmetry combined leads to selection rules, additional to those following from covariance and gauge invariance arguments. Besides rigorous selection rules which hold for certain processes involving neutral particles (mesons and photons) only, there exist weak selection rules according to which certain Boson–Boson transitions are less probable by a factor $e^2/\hbar c$ than the corresponding transitions in which an additional photon is emitted. The rules are stated and some examples are given. A.

530.145

7937. Scattering by a charged thread. S. M. RYTOV. Letter in *Zh. Eksper. Teor. Fiz.*, **22**, 510–11 (*No.* 4, 1952) *In Russian.*

Angular distribution of classical scattering by a straight filament is calculated. W. J. SWIATECKI

530.145

7938. The vacuum in quantum electrodynamics. H. UMEZAWA AND S. KAMEFUCHI. *Progr. Theor. Phys.*, **6**, 543–58 (*July–Aug.*, 1951).

Without use of perturbation calculation a general formula is derived for the vacuum-induced current due to external electromagnetic field. This formula is valid for any charged field with arbitrary spin and interaction type. The terms corresponding to self-charge and observable current are shown to be of negative signs. The condition for the finiteness of the self-charge is also considered. These circumstances give rise to the serious difficulties in solving the problem of divergence of self-charge, etc., from the standpoint of the realistic mixed field theory. An application of this formula to induced current in the e^2-approximation is stated in detail. In order to settle these difficulties entirely it is expected that the further material property may be introduced for the vacuum. A.

530.145

7939. Note on the longitudinal and scalar photons. R. UTIYAMA, T. IMAMURA, S. SUNAKAWA AND T. DODO. *Progr. Theor. Phys.*, **6**, 587–603 (*July–Aug.*, 1951).

A new kind of ambiguity and inconsistency pertaining to the longitudinal and scalar photons was investigated. A clarification of this problem is thought to have been made by introducing an artificial convergence factor g_n into the state vector. A.

530.145

7940. The dynamical theory of magnetic monopoles. S. SHANMUGADHASAN. *Canad. J. Phys.*, **30**, 218–25 (*May*, 1952).

The theory of electric charges and magnetic monopoles has been set up by Dirac by expressing the electromagnetic field tensor in terms of one four-potential and of the variables describing the strings attached to each magnetic monopole. In this reformulation of Dirac's theory the field tensor is expressed in terms of two four-potentials, one corresponding to charges and the other to monopoles, and the action principle for the equations of motion is set up in terms of the two four-potentials and of the tensors dual to them. Thus there is formal symmetry as far as is possible in the treatment of the charges and the monopoles. Also the mathematics is direct and neat. Though the physical content is the same as that of Dirac, a natural generalization of the Fermi form of electrodynamics subject to the restriction that the same particle cannot have both charge and monopole is obtained here. A.

530.145

7941. On a modified definition of Riesz potential and its correspondence to the Wentzel potential. L. S. KOTHARI AND P. L. BHATNAGAR. *Proc. Nat. Inst. Sci. India*, **18**, 171–5 (*May–June*, 1952).

It is known that the usual definition of the Riesz potential gives an analytic continuation to $\alpha = 0$, the Maxwell potential, whereas the modified definition given by Auluck and Kothari [Abstr. 5092 (1951)] gives the Wentzel potential. In this paper the correspondence between the modified Riesz potential and the Wentzel potential is explicitly worked out. A.

530.145

7942. The mass of a photon. L. S. KOTHARI. Letter in *Phys. Rev.*, **87**, 536 (*Aug.* 1, 1952).

The use of Auluck and Kothari's definition [Abstr. 5092 (1951)] of the Riesz potential A_μ^α is shown equivalent to assuming massive photons with a

continuous mass distribution, of which only those with zero mass remain in the limit $\alpha \to 0$.

R. H. DALITZ

530.145

7943. Recoil effect on electron-proton forces and inapplicability of energy law. G. ARAKI AND S. HUZINAGA. *Progr. Theor. Phys.*, **6**, 673–83 (*Sept.–Oct.*, 1951).

Bethe and Fermi showed that Breit's formula for the two-electron interaction transmitted by photons can be obtained according to quantum electrodynamics if the recoil effect is neglected. It was shown by Breit himself that his formula was not in complete agreement with experiment. The discrepancy was shown to come from a term which was proportional to e^4 in the Pauli approximation, but its true origin has not yet fully been discovered. In the present paper it is shown that this surplus term is due to the neglect of the recoil effect and the discrepancy disappears when the interaction is derived correctly, taking into account the effect of the electron and proton recoils according to the method of the unitary transformation. Further it has generally been known that the electron-proton interaction transmitted by photons takes the form which was previously derived by Møller for the two-electron interaction if the conservation law is applied to the total energy of the two particles in the free state. In the present paper it is shown that the application of the energy law gives rise to an incorrect result in case of hydrogen atom. According to Møller's formula the interval between $2^2S_{1/2}$ and $2^2P_{1/2}$ levels of the hydrogen atom becomes too large. Its value amounts to 7273 Mc/s in contradiction to the Lamb–Retherford experiment. Therefore it is concluded that the energy law can not be made use of in general when forces between fermions in the bound states are derived. A.

530.145

7944. On the path integral and its application. Y. MURAI. *Progr. Theor. Phys.*, **6**, 762–71 (*Sept.–Oct.*, 1951).

The exact form of the path integral has been obtained by the method of ordered operators. For illustration the result has been applied to the free Dirac particle. It has been further shown that the electromagnetic mass of the electron appears in the path integral in a natural way when the interaction with the self-field is considered. A.

530.145

7945. On the establishment of the mass-charge renormalization and its application to the Maxwell field. H. SALECKER. *Z. Naturforsch.*, **7a**, 381–6 (*June*, 1952) *In German.*

Renormalization is exhibited as a consequence of the standard perturbation procedure in which the Hamiltonian H_0 for the force-free case is first written down and then modified by introducing the interaction term H'. If the observed values for m and e are used in H_0, the perturbations δm and δe must be subtracted from H' and in this way the standard formulae are established. The method is extended to the case of the photon by regarding the unobservable rest-mass m_0 as undetermined, and requiring that the observed value $m_0 + \delta m_0$ shall be zero.

R. A. NEWING

530.145

7946. Are direct nucleus-lepton interactions charge-independent? F. J. BELINFANTE. Letter in *Phys. Rev.*, **87**, 521 (*Aug.* 1, 1952).

This is unlikely because the direct interactions describing phenomenologically the Lamb shift, the neutron-electron attraction and the coefficient in Fermi's theory of β-decay are all of different orders of magnitude. This is as expected since these interactions arise through different fields in the 3 cases.

W. J. SWIATECKI

530.145

7947. The electromagnetic properties of Dirac particles. L. L. FOLDY. *Phys. Rev.*, **87**, 688–93 (*Sept.* 1, 1952).

A framework for describing those electromagnetic properties of Dirac (spin-$\frac{1}{2}$) particles which determine their behaviour when moving with low momentum through weak slowly-varying external electromagnetic fields is developed by finding the most general interaction terms which may be added to the Dirac equation for the particle subject to appropriate conditions. The interaction terms found form an infinite series involving arbitrarily high derivatives of the electromagnetic potentials evaluated at the position of the particle. The series of coefficients of these terms then characterize the properties to be described and can be interpreted as a series of moments of the charge and current distribution associated with the Dirac particle. The first coefficient represents the charge of the particle, the second its anomalous magnetic moment. The third is a measure of the spatial extent of the particle's charge distribution and the corresponding term describes a direct interaction of the particle and the charge distribution responsible for the external electromagnetic field, Higher terms in the series describe direct interactions of the particle with various derivatives of the external charge and current distribution. The correct physical interpretation of the terms is examined by transforming to the Foldy–Wouthuysen (nonrelativistic) representation of the Dirac equation. The consistency of the framework developed with field theoretical results is discussed. Limitations of the characterization derived here and the possibilities of broadening the assumptions on which it is based are examined. The results are applied in the succeeding paper to the interpretation of the electromagnetic properties of nucleons with particular reference to the electron-neutron interaction. A.

530.145

7948. The electron-neutron interaction. L. L. FOLDY. *Phys. Rev.*, **87**, 693–6 (*Sept.* 1, 1952).

The known electromagnetic properties of nucleons, assuming that the electron-neutron interaction is fundamentally of electromagnetic origin, are fitted into the phenomenological framework developed in the paper reported in the preceding abstract and the results compared with predictions of weak coupling meson theories. The detailed comparison shows that the intrinsic electron-neutron interaction is somewhat smaller than predicted and it is suggested that even in the more favourable cases, the rough agreement as to order of magnitude may be largely due to a fortuitous cancellation of different contributions, which may easily be upset when higher order effects are included in

the theory. Even apart from the detailed calculations, it is indicated that the observed intrinsic electron-neutron interaction is considerably smaller than order-of-magnitude expectations from general meson-theoretical principles. The results emphasize the importance of more accurate experimental determinations of the electron-neutron interaction, since a smaller value of the intrinsic interaction will either pose a very stringent test for any meson theory or require a critical re-evaluation of our present ideas regarding nucleonic structure. Some phenomena related to the electron-neutron interaction and the possibility that the intrinsic interaction may be non-electromagnetic in origin are briefly discussed. A.

530.145

7949. Moments of the angular distribution for high energy nuclear collisions. B. A. CHARTRES AND H. MESSEL. *Phys. Rev.*, **87**, 748–9 (*Sept.* 1, 1952).

Detailed results for the mean square angle of scattering of nucleons in high-energy nucleon-nucleus collisions are presented using the accurate expressions previously determined by Messel and Green [Abstr. 8514 (1951), 517, 5546 (1952)]. Curves are given both for light and heavy elements. Confirmation of the results presented would provide valuable information on the differential cross-section for nucleon-nucleon collisions. A.

530.145

7950. Radiative correction to the angular distribution of nuclear recoils from electron scattering. L. I. SCHIFF. *Phys. Rev.*, **87**, 750–2 (*Sept.* 1, 1952).

A calculation is made of the cross-section for the recoil of nuclei from electron scattering when the angle of recoil is specified but the recoil energy is not. The influence of radiation is taken into account. Use is made of the calculation by Drell (abstract following) to gauge the accuracy of the computed cross-section for light nuclei; the fractional error is believed to be substantially smaller than the ratio of the recoil nucleus velocity to the velocity of light. A.

530.145

7951. Recoil correction to bremsstrahlung cross section. S. D. DRELL. *Phys. Rev.*, **87**, 753–5 (*Sept.* 1, 1952).

A correction to the Bethe–Heitler differential cross-section for bremsstrahlung (or pair production) due to the recoil of the source of the Coulomb field (proton) is derived. Terms of order v/c, where v is the recoil velocity of the scattering centre, are studied. They are shown not to contribute in the analysis of electron-proton scattering given by Schiff (preceding abstract). A.

530.145

7952. Cosine interaction between nucleons. A. DE-SHALIT. *Phys. Rev.*, **87**, 843 (*Sept.* 1, 1952).

Some properties of a nuclear interaction proportional to $(\mathbf{j}_1 \cdot \mathbf{j}_2)$ are investigated. Although this interaction yields, qualitatively, reasonable results for even–even nuclei, it fails when applied to odd nuclei, the situation being similar to that in the long-range Majorana interaction. A.

530.145

7953. Pseudoscalar interaction in the theory of beta-decay. T. AHRENS, E. FEENBERG AND H. PRIMAKOFF. Letter in *Phys. Rev.*, **87**, 663 (*Aug.* 15, 1952).

The relativistic ps. scalar matrix element is reduced to a partially non-relativistic form and the correction factor in the case of $\Delta I = 0$, (yes) transitions is estimated. W. J. SWIATECKI

530.145

7954. Nucleon recoil and the electron-neutron interaction. L. L. FOLDY. Letter in *Phys. Rev.*, **87**, 675 (*Aug.* 15, 1952).

The observed smallness of this interaction is attributed to the proton recoil which partially cancels the charge cloud of negative mesons surrounding the neutron and this is illustrated using results of Borowitz and Kohn [Abstr. 1514 (1950)]. W. J. SWIATECKI

530.145

7955. Interaction between electron and one-dimensional electromagnetic field. N. ROSEN. *Phys. Rev.*, **87**, 940–2 (*Sept.* 15, 1952).

For a single electron interacting with the quantized transverse electromagnetic field it is found that, in the one-dimensional case, the Schrödinger equation can be put into a form like that of a system of coupled harmonic oscillators. From the classical frequencies of the normal modes of oscillation of such a system the quantal energy can be determined. While the perturbation method gives a logarithmic divergence in the interaction energy, one finds by the present method that the energy diverges like the square root of a logarithm. A.

530.145

7956. An application of the theory of the effective range to meson-nucleon scattering. K. A. BRUECKNER. *Phys. Rev.*, **87**, 1026–30 (*Sept.* 15, 1952).

A theory of the effective range for *P*-state scattering is developed and the extent of its validity is investigated. It is found that a parameter of the theory can meaningfully be identified as an effective range and that the energy dependence of the effective range is very weak. The resulting formula for the energy dependence of the phase shift is shown to be exactly equivalent, if the relativistic energy is used, to a simple form of the Wigner–Eisenbud one-level formula for *P*-states in which the level shift is neglected. An application to meson-nucleon scattering is made which illustrates the use of the method and which suggests a high lying resonance in the scattering. A.

530.145

7957. The application of the method of Fock's functionals to the question of self-energy. YU V. NOVOZHILOV. *Zh. Eksper. Teor. Fiz.*, **22**, 264–75 (*No.* 3, 1952) *In Russian.*

Using this method the mass-renormalization is the same whether the particle is bound or not. The many-times formalism and second quantization of the electron can be avoided. In the definition of the self-energy operator there is an arbitrariness in the division into positive and negative states, but an approximate level shift calculation can be made unambiguously. An expansion of the wave function of the electron in powers of the external field gives the radiative corrections including the additional magnetic moment. W. J. SWIATECKI

530.145

7958. Some recent advances of the theory of atomic collisions. B. KWAL. *Ann. Inst. Poincaré*, **12**, 171–206 (*No.* 4, 1951) *In French.*

A review article. A section on angular distributions includes: Rutherford formula; Born approximation; relativistic wave equation; Williams' theory of multiple collisions; effect of screening; Goudsmit and Saunderson's analysis of the distribution function in spherical harmonics and comparison with experiment; Bethe's and Williams' expressions for the mean curvature of a scattered track; the diffusion equation exact solutions showing the transition from simple to multiple scattering). On energy loss subjects covered are: the formulae of Bethe and Bohr; Landau's formula for the most probable loss; energy loss in a highly ionized medium (plasma oscillations); loss in polarizable medium (Cherenkov radiation); formulae of Franck and Tamm and of Fermi (the loss tends to a limit for extreme energies).

W. J. SWIATECKI

530.145

7959. Radiation corrections in quantum electrodynamics. I. A. D. GALANIN. *Zh. Eksper. Teor. Fiz.*, **22**, 448–61 (*No.* 4, 1952) *In Russian.*

On the basis of Heisenberg's representation operators are obtained for any approximation as a sequence of powers of $e^2/\hbar c$, with detailed application to the one-electron problem. All diagrams are contained in this scheme, showing equivalence with Feynman's and Dyson's theories. J. JACOBS

530.145

7960. Radiation corrections in quantum electrodynamics. II. A. D. GALANIN. *Zh. Eksper. Teor. Fiz.*, **22**, 462–70 (*No.* 4, 1952) *In Russian.*

Important is the construction of a Green's function for interacting fields, modified by the interaction of particle and vacuum. Application to the many-electron problem, and to the case when real photons are present. J. JACOBS

530.145

7961. On the definition of the renormalization constants in quantum electrodynamics. G. KÄLLÉN. *Helv. Phys. Acta*, **24**, 417–34 (*No.* 4, 1952).

A formulation of quantum electrodynamics in terms of the renormalized Heisenberg operators and the experimental mass and charge of the electron is given. The renormalization constants are implicitly defined and expressed as integrals over finite functions in momentum space. No discussion of the convergence of these integrals or of the existence of rigorous solutions is given. A.

530.145

7962. On the production of negative protons. M. TAKETANI AND S. MACHIDA. *Progr. Theor. Phys.*, **6**, 559–71 (*July–Aug.*, 1951).

Cross-sections for the production of negative protons in various processes was calculated assuming the pseudoscalar meson theory. Numerical results are summarized. Owing to the lack of satisfactory theory for the high-energy processes considered here, the Weizsäcker–Williams method has been employed. Taking account of the reactions and the non-linearities of the meson field phenomenologically to some extent, the case of modified meson spectrum as suggested by Heisenberg has been treated. Obtained cross-sections for the production of negative protons by the nucleon–nucleon collisions are smaller by the factor of about 10^{-4} in the case of modified meson spectrum than those when the reactions and non-linearities of meson field are neglected completely. Also the cross-section for the production of negative protons by proton–proton collisions near threshold is calculated by the method of Feynman's relativistic perturbation. A.

530.145

7963. The meson theory of nuclear forces. I. The deuteron ground state and low energy neutron-proton scattering. M. TAKETANI, S. MACHIDA AND S. O-NUMA. *Progr. Theor. Phys.*, **7**, 45–56 (*Jan.*, 1952).

Adopting the new method of the theory of nuclear forces (abstract following), the deuteron ground state and low energy neutron-proton scattering have been investigated. The symmetrical pseudoscalar π-meson potentials including second- and fourth-order terms are assumed in the outside region, while in the inside region where the static meson potential becomes meaningless, phenomenological potentials represented by square well are adopted. It is shown that the experimental data can then be accounted for if the value $0{\cdot}09 \sim 0{\cdot}10$ is taken as the magnitude of the coupling constant between π-meson and nucleon. Saturation does not result from these potentials in the static approximation. A.

530.145

7964. On the method of the theory of nuclear forces. M. TAKETANI, S. NAKAMURA AND M. SASAKI. *Progr. Theor. Phys.*, **6**, 581–6 (*July–Aug.*, 1951).

From the standpoint of the meson theory of nuclear force, results of current analysis on phenomenological nuclear potentials are re-examined. A new method of the theory of nuclear forces is proposed. Meson potentials were employed for the outside region, and phenomenological parameters for the inside region of the nuclear forces. A.

530.145

7965. On the self-energies of nucleons. H. ENATSU. *Progr. Theor. Phys.*, **6**, 643–64 (*Sept.–Oct.*, 1951).

The 2nd-order self-energies of nucleons are evaluated by making use of the recent covariant formalism. If the symmetrical pseudoscalar type with pseudovector coupling is assumed for the π-meson, it will be shown that, in order to cancel divergencies of self-energies of nucleons due to π-mesons, it is necessary to introduce heavy mesons which obey the symmetrical scalar field with vector coupling. Their coupling constants are larger than those of π-mesons, and their masses are 1474 m_e. A.

530.145

7966. Self-energies of nucleons and the mass spectra of heavy particles. H. ENATSU. Letter in *Phys. Rev.*, **85**, 483–4 (*Feb.* 1, 1952).

The author's considerations, in *Progr. Theor. Phys.* **6**, 434 (1951) and preceding abstract, aiming at the removal of nucleon divergencies using heavy mesons, are modified to bring them in line with more recent data on κ, V and τ-mesons. W. J. SWIATECKI

530.145

7967. The scattering of mesons by nuclear particles. I. R. C. MAJUMDAR, A. S. APTE AND M. K. SUNDARESAN. *Progr. Theor. Phys.*, **6**, 737–47 (*Sept.–Oct.*, 1951).

A general relativistic theory of scattering of mesons including the radiation damping has been worked out in which the incident pseudoscalar (vector) meson is scattered by nuclear particles into a pseudoscalar or a vector meson. The cross-sections for the scattering processes involving charged mesons only are given and it is shown that the integral equation of the radiation damping can be solved exactly in a very simple way. The extension of the present scheme of the scattering of mesons to that of Tomonaga–Schwinger–Feynman–Dyson's covariant formalism and the scattering processes involving neutral mesons, together with discussions on scattering experiments on the π-meson will be the subject-matter of subsequent papers. A.

530.145

7968. On the adiabatic nuclear potential. I. K. NISHIJIMA. *Progr. Theor. Phys.*, **6**, 815–28 (*Sept.–Oct.*, 1951).

The "nuclear force" is investigated on a non-relativistic basis. It is concluded that no single approximation such as weak coupling or strong coupling will be capable of explaining the phenomena, and that higher-order calculations would not remove discrepancies, if the adiabatic nuclear potential computed up to 4th order could not fit the experimental data in the low energy region where the weak coupling theory is expected to hold. The 4th-order adiabatic nuclear potential is calculated by the method of canonical transformations. In order to obtain a meaningful 4th-order adiabatic potential, it is necessary that the 2nd-order one be derived in the Schroedinger approximation without referring to the Pauli approximation. The potential thus derived agrees with the one derived by the *S*-matrix method. A.

530.145

7969. Equivalence theorems for pseudoscalar coupling. J. M. BERGER, L. L. FOLDY AND R. K. OSBORN. *Phys. Rev.*, **87**, 1061–5 (*Sept.* 15, 1952).

By a unitary transformation a rigorous equivalence theorem is established for the pseudoscalar coupling of pseudoscalar mesons (neutral and charged) to a second-quantized nucleon field. By the transformation the linear pseudoscalar coupling is eliminated in favour of a nonlinear pseudovector coupling term together with other terms. Among these is a term corresponding to a variation of the effective rest mass of the nucleons with position through its dependence on the meson potentials. The question of the connection of the nonlinear pseudovector coupling with heuristic proposals that such a coupling may account for the saturation of nuclear forces and the independence of single nucleon motions in nuclei is briefly discussed. The new representation of the Hamiltonian may have particular value in constructing a strong coupling theory of pseudoscalar coupled meson fields. Some theorems on a class of unitary transformations of which the present transformation is an example are stated and proved in an appendix. A.

530.145

7970. Structure of the nucleon. R. G. SACHS. *Phys. Rev.*, **87**, 1100–10 (*Sept.* 15, 1952).

An attempt is made to determine what restrictions are imposed on the nucleon wave functional by the known values of the nucleon moments and by the neutron-electron interaction. The nucleon is assumed to consist of a core particle (nucleore) of spin $\frac{1}{2}$ surrounded by a pion field. No detailed reference is made to the interaction producing the field. Nucleore recoil is neglected. It is found that the neutron and proton moments satisfy a mirror condition $\mathfrak{M}_n + \mathfrak{M}_p = 1 - (4/3)P_1$, where P_1 is the probability that pions (any number or charge) occur in the field with total orbital angular momentum $L = 1$. Insertion of the measured values of the moments in the equation yields $P_1 = 9\%$. A model of the nucleon in which one pion plays the predominant role is not consistent with this result. This is probably the underlying reason for the failure of the weak coupling theory to give the correct ratio of neutron to proton moments. The neutron and proton moments can be accounted for if the field contains at least two pions with appreciable probability. A successful model consists of 91% bare nucleore, and 9% a pair of mesons, each in p states forming the state $L = 1$. The neutron electron interaction is shown to depend on the mean square radius of the charge distribution, $\langle r^2 \rangle_{Av}$, in the nucleon. If only one or two pions with $L = 1$ are contained in the proper field with appreciable probability, the observed interaction combined with the above value of P_1 leads to the very reasonable value of the mean square displacement of a pion, $\simeq 0{\cdot}5$ times the square of the Compton wavelength of the pion. The results suggest strongly that a weak nonlinear coupling would be capable of accounting for the data, but a linear coupling of intermediate strength cannot be excluded. An analysis of the pseudoscalar field in terms of spherical waves is given in the Appendix. Consideration is also given there to the space and time inversion properties of the field functionals. A.

530.145

7971. Bound states between nucleon and anti-nucleon. G. EDER. *Z. Phys.*, **132**, 330–4 (*No.* 3, 1952) *In German.*

Using the Bethe–Salpeter equation with only the simplest graph, the bound states of nucleon and anti-nucleon, due to their coupling with the meson field, are discussed. For sc. and psc. theories no bound states are found, whilst for vector theory there exists one bound state in this approximation. R. H. DALITZ

530.145

7972. Higher meson theory approximation to the magnetic moment of the proton. A. THELLUNG. *Helv. Phys. Acta*, **25**, 307–38 (*No.* 4, 1952) *In German.*

The 4th-order corrections to the magnetic moment of the proton, due to the coupling with a neutral pseudoscalar meson field, are calculated within the framework of Dyson's radiation theory, a slightly different method of self-energy subtraction being used. The integrations over the Feynman parameters are carried out only in the approximation $\delta^2 = (\mu/M)^2 = 0$. The results are unable to compensate the wrong 2nd-order contributions. Some questions

oncerning the renormalization of the coupling onstant are discussed in detail and it is shown that, o a certain extent, the definition of what has to be nterpreted as renormalization terms is arbitrary, without modifying the quantitative predictions of a heory. A.

530.145.6

7973. Generalized relativistic wave equations. F. I. Fedorov. *Dokl. Akad. Nauk SSSR*, **82**, 37–40 (*No.* 1, 1952) *In Russian.*

These are of the type $(\gamma_k\nabla_k + i\gamma_0)\psi = 0$, where γ_0 is a matrix. In the case when $|\gamma_0| = 0$ Maxwell's equations can be deduced with the Lorentz condition following automatically from a Lagrangian, which then involves an auxiliary scalar field variable. A special case is the Bopp–Podolsky electrodynamics.

W. J. SWIATECKI

530.162

7974. Generalized theory of thermal fluctuations. H. Takahasi. *J. Phys. Soc. Japan*, **7**, 439–46 (*Sept.–Oct.*, 1952).

A general theory of thermal fluctuations, or Brownian motions, in a system in thermal equilibrium is developed on the basis of Gibbs's classical statistical mechanics. Taking advantage of the deterministic character of classical systems and applying fluctuation formula for a canonical ensemble, a formula for the cross-correlation function for two quantities u and X is given as $u(t+\tau)X(t) = kT[\Psi(\infty) - \Psi(\tau)]$, where $\Psi(\tau)$ is the after-effect function for u responding to a unit-function change of x, while X is the force associated with the generalized co-ordinate x. Thus the formula indicates the identity of the statistical after-effect to the dynamical after-effect. It may be shown to comprise virtually all the known results pertaining to thermal fluctuation derivable from classical statistical mechanics. A generalization of Onsager's reciprocity relation to a system with after-effect is also obtained. A.

530.162

7975. A generalization of the classical random-walk problem and a simple model of Brownian motion based thereon. G. Klein. *Proc. Roy. Soc. Edinb. A*, **63**, 268–79 (*Pt III*, 1952).

Suggested by the analogy between the classical one-dimensional random-walk and the approximate (diffusion) theory of Brownian motion, a generalization of the random-walk is proposed to serve as a model for the more accurate description of the phenomenon. Using the methods of the calculus of finite differences, some general results are obtained concerning averages based on a time-varying bivariate discrete probability distribution in which the variates stand in the particular relation of "position" and "velocity." These are applied to the special cases of Brownian motion from initial thermal equilibrium, and from arbitrary initial kinetic energy. In the latter case the model describes accurately quantized Brownian motion of two energy states, one of zero energy. A.

530.162 : 536.423.4

7976. Condensation phenomenon of an ideal Einstein–Bose gas. II. O. Halpern. Letter in *Phys. Rev.*, **87**, 520 (*Aug.* 1, 1952).

For Pt I, see Abstr. 5562 (1952). For an E–B gas in a gravitational field, the thickness of the condensed layer on the floor in the author's treatment agrees with the WBK result of Lamb and Nordsieck (1941). R. H. DALITZ

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531.266

7977. Laws of attraction having a certain generalized Newtonian property. H. D. Block. *J. Math. Phys.*, **31**, 151–3 (*July*, 1952).

Assuming an attraction derivable from a potential $v(r)$, it is shown that the interaction energy of two non-intersecting spherical distributions of matter of radii a, b and at a distance R, is of the form $m_1m_2\phi(a,b)v(R)$ only if $v(r) = (1/r)(Ae^{\beta r} + Be^{-\beta r})$ where A, B, β are constants, β being real, zero or imaginary. R. A. NEWING

531.38

7978. Bodies rocking on planes and cylinders, spheroids and spindles rocking on planes, balls and other symmetrical bodies rocking in elliptical and other holes. J. Satterly. *Amer. J. Phys.*, **20**, 338–52 (*Sept.*, 1952).

In continuance of earlier work [Abstr. 1488 (1952)], the rocking of bodies of other shapes resting on different supports has been studied. The examples afford a useful study of the dynamical equations appropriate to such vibrations and provide simple and inexpensive experiments for students in the laboratory. A.

531.383

7979. On a case of instability produced by rotation. J. L. Synge. *Phil. Mag.*, **43**, 724–8 (*July*, 1952).

Deals with the same problem as Braams [Abstr. 7056 (1952)] though independently. The behaviour of a spinning top whose outward form consists of a spherical surface S and a projecting cylindrical leg L, the central line of L lying on a diameter of S, is discussed mathematically. It is shown that the observed behaviour occurs when the exterior form is a surface of revolution, the mass-centre lies on the axis of figure outside the segment of that axis joining the centres of curvature at its two ends but close to one of them, at the mass-centre the axis of figure is a principal axis of inertia but the momental ellipsoid is not a surface of revolution about the axis of figure, and the differences between the principal moments of inertia at the mass-centre are small but satisfy certain inequalities. S. WEINTROUB

MECHANICAL MEASUREMENTS 531.7

531.715.2

7980. A method of measuring and grading microscopic spherical particles. V. Timbrell. Letter in *Nature* [*Lond.*] **170**, 318–19 (*Aug.* 23, 1952).

An optical system is suggested whereby two images are produced with a variable separation for each

particle. It is then simple to adjust the separation until the particles just touch. A modification is given to enable particles to be classified in size ranges.

J. M. HOUGH

531.717.1 : 621.319.4

7981. Measurement of the thickness of capacitor paper. W. Souder and S. B. Newman. *Circ. Nat. Bur. Stand., No.* 532, 10 *pp.* (1952).

The definition of thickness must be carefully analysed before choosing an instrument for such measurements. Three methods are available: (1) by direct observation across an edge section by means of a micrometer microscope, (2) by measuring the separation of two geometric surfaces between which one or more specimens are placed, and (3) by determining the mass of a definite area of sample and computing the thickness, using the density parameter. Measurements have been made on some commercial thin capacitor papers, using the interferometer, micrometer microscope, mechanical micrometers, and the surface analyser. These data have been analysed. It has been found that the precision dial micrometer or the precision screw micrometer may be used for such measurements. The size and type of contact and the load to be applied will depend on the needs of the manufacturer and user of the paper. A.

531.76 : 541.18

7982. A photoelectric method of timing freely falling particles. E. B. Christiansen and D. H. Barker. *Rev. Sci. Instrum.*, **23,** 427–30 (*Aug.*, 1952).

A method of timing particles, falling freely in a fluid medium, is described. The method utilizes the light reflected from a particle as it passes the fields of view of two photomultiplier cells. The method has been used in a study of shape and density effects on settling rates of particulate matter in air and in water. A.

MECHANICS OF FLUIDS 532

532.13

7983. Direct calculation of viscosities of liquids. M. S. Telang. Letter in *Nature* [*Lond.*] **170,** 160–1 (*July* 26, 1952).

A discussion of the free volume ($V - b$) term in the author's equation for viscosity [see Abstr. 5271 (1949)]. T. C. TOYE

532.13 : 541.182.6

7984. The viscosity of suspensions of rigid spheres. R. Roscoe. *Brit. J. Appl. Phys.*, **3,** 267–9 (*Aug.*, 1952).

An explanation is given of the dependence of the relative viscosity on the size distribution of the suspended spheres, an effect recently observed by Ward and Whitmore [Abstr. 865 (1951)]. It is shown theoretically that if the spheres are of very diverse sizes, the relative viscosity is $(1 - c)^{-2\cdot5}$ for all values of the volume concentration c. For spheres of equal size, the validity of the Einstein expression for the relative viscosity $(1 + 2\cdot5c)$ is restricted to concentrations well below $c = 0\cdot05$; while for medium and high concentrations the relative viscosity is given by the theoretical expression $(1 - 1\cdot35c)^{-2\cdot5}$. The use of the latter formula in interpreting measurements on the viscosity of solutions is briefly indicated. A.

532.51

7985. Another fluid paradox. W. A. Nierenberg. Letter in *Amer. J. Phys.*, **20,** 379 (*Sept.*, 1952).

Lamb, in discussing the scattering of an incident plane wave by a free, spherical obstacle of radius r, shows that (1) the motion of the obstacle vanishes if its density is infinite compared with that of the fluid, (2) the motion of the obstacle just equals that of the fluid if their densities just match and (3) paradoxically, the acceleration of the obstacle is just $3\times$ that of the fluid if the density of the obstacle vanishes. Throughout it is assumed that the local wavelength is large compared with r. A simpler and more intuitive derivation of this paradoxical result is now obtained by considering a frame of reference accelerating with the fluid, which is assumed to be in rectilinear motion, and taking into account the increased mass of the sphere due to acceleration of the displaced water.

J. S. G. THOMAS

532.517.2

7986. Stability of the laminar inlet-flow prior to the formation of Poiseuille régime. I. T. Tatsumi. *J. Phys. Soc. Japan*, **7,** 489–95 (*Sept.–Oct.*, 1952).

Velocity distribution in the axisymmetric laminar inlet-flow through a circular tube is obtained, under the assumption of "almost similarity" of velocity profiles. Theoretical velocity distribution curves obtained agree fairly well with the experimental one in a rather limited region near the entrance where the approximation is valid. A.

532.517.2

7987. Stability of the laminar inlet-flow prior to the formation of Poiseuille régime. II. T. Tatsumi. *J. Phys. Soc. Japan*, **7,** 495–502 (*Sept.–Oct.*, 1952).

As a continuation of Pt I, the stability of the inlet-flow is now discussed, obtaining the result that there exists a stability limit whose minimum critical Reynolds number is 9700 at the point 17 times of the radius of tube downstream from its entrance. A.

532.58

7988. Analysis of the swimming of long and narrow animals. G. Taylor. *Proc. Roy. Soc. A*, **214,** 158–83 (*Aug.* 21, 1952).

The swimming is idealized by considering the equilibrium of a flexible cylinder immersed in water when waves of bending of constant amplitude travel down it at constant speed. Relevant aerodynamic data for smooth cylinders are first generalized to make them applicable over a wide range of speed and cylinder diameter. The results of calculation are compared with Gray's photographs (1939) of a swimming snake and a leech. The amplitude of the waves which produce the greatest forward speed for a given output of energy is calculated and found, in the case of the snake, to be very close to that revealed by photographs. Similar calculations using force formulae applicable to rough cylinders yield results which differ from those for smooth ones in that when the roughness is sufficiently great and has a certain directional character propulsion can be achieved by a wave of bending which is propagated forward instead of backward. Gray's photographs of a marine worm show that this does in fact occur. See also Abstr. 2461 (1952). A.

532.53

7989. Pulsation of hydrodynamic pressure at the boundary of an open turbulent stream. M. S. FOMICHEV. *Gidrotekh. Stroit., No.* 4, 32–5 (1952) *In Russian.*

Pulsation of hydrodynamic pressure causes vibration of hydro-engineering structures. Induction type probes were used to investigate the variation of pressure on the face of a large dam. Analysis of results shows that pulsations of dynamic pressure and velocity are intrinsic to any turbulent flow, and depend on the shape of the bed and its roughness, presence of aeration and discontinuities, shape of obstacles existing in the path of the stream. In any turbulent flow the amplitude of pulsation of pressure changes in proportion to the square of mean velocity of the stream. Increase in the height of waterfall increases both the amplitude and energy of pressure pulsation. Increase in the thickness of the stream decreases this amplitude. J. LUKASZEWICZ

532.59

7990. Two-dimensional gravity waves of finite energy. J. KAMPÉ DE FERIET AND J. KOTIK. *C.R. Acad. Sci.* [*Paris*] **235,** 230–2 (*July* 21, 1952) *In French.*

The two-dimensional motion of a gravitating liquid of infinite depth, the free surface of which has initially a given form, the fluid having initially no velocity, is discussed mathematically. A solution is derived for the motion in the case in which the total energy is finite. An expression is derived for the velocity potential, and this is shown to satisfy the general conditions of the linearized theory of gravitating waves and the initial boundary conditions.

J. S. G. THOMAS

532.595 : 532.13

7991. Forced oscillations of an incompressible, viscous liquid in a rigid, horizontal pipe. Calculation of the friction. P. LAMBOSSY. *Helv. Phys. Acta,* **25,** 371–86 (*No.* 4, 1952) *In French.*

The radial distribution of the longitudinal velocity of an incompressible, viscous liquid, flowing in a rigid, horizontal pipe, and subjected to harmonic fluctuations of pressure between its ends, given by $p_1 - p_0 = \rho l A \cos \omega t$, ρ denoting the density of the liquid and l the length of the pipe, is discussed. It is shown that the velocity profile of the flow depends, apart from the time t, solely upon a quantity $z = R(\rho\omega/\eta)^{1/2}$, where R is the internal radius of the pipe, and η is the viscosity of the liquid. The phase of liquid flowing near the wall of the pipe is in advance of that of the central column of liquid. An expression for the frictional force, F, per unit area of the boundary, associated with the flow is derived in the form $F = (-\rho R\omega U/2\alpha) - [\rho R(\beta/\alpha - 1)/2]du/dt$ where U is the mean cross-sectional velocity and α and β are defined functions of z. Forms of the cross-sectional profile of velocities are derived, and the special cases in which $z = 0$ and α are briefly discussed.

J. S. G. THOMAS

532.623

7992. The behaviour of the surface of gas bubbles moving in liquids. B. STUKE. Note in *Naturwissenschaften,* **39,** 325–6 (*No.* 14, 1952) *In German.*

The rate of rise of oxygen bubbles in pure water conforms with Stokes's law at bubble diameters $<0{\cdot}1$ mm, rises to a max. at $1{\cdot}7$ mm dia, and then decreases to a finite limit with further increase in dia. The presence of a trace of surface-active material causes a spectacular decrease in the rate of rise: at a concentration of $4{\cdot}5 \times 10^{-4}$ g mol/l caproic acid the max. in the rate-diameter curve is no longer observed. The phenomenon is explained in terms of the energy needed to produce a continual rearrangement in the interfacial layer as the bubble rises, if the bubble is big enough for the viscous forces called into play to disrupt an initial surface rigidity. Spiral motion of the bubble can occur when there is internal circulation.

J. G. OLDROYD

MOLECULAR THEORY OF LIQUIDS 532.7

532.71

7993. Note on the free volume equation of state for hard spheres. W. W. WOOD. Letter in *J. Chem. Phys.,* **20,** 1334 (*Aug.,* 1952).

Kirkwood [Abstr. 5573 (1950)] has given a set of equations of which the first approximation to the solution yields a partition function identical with that of the Lennard–Jones–Devonshire free volume theory. The present note points out that the equations may be solved exactly for rigid spheres and the resulting equation of state is obtained. This is the same as that obtained from the Lennard–Jones–Devonshire theory. F. E. HOARE

532.72

7994. Tracer diffusion in liquids. II. The self diffusion of sodium ion in aqueous sodium chloride solutions. J. H. WANG AND S. MILLER. Note in *J. Amer. Chem. Soc.,* **74,** 1611–12 (*March* 20, 1952).

For Pt I, see Abstr. 4948 (1952). The self-diffusion coefficients of sodium ion in aqueous sodium chloride solutions is determined using the capillary tube method. For small concentrations the results agree with Onsager's formula for tracer diffusion. T. C. TOYE

532.72

7995. Tracer diffusion in liquids. III. The self diffusion of chloride ion in aqueous sodium chloride solutions. J. H. WANG. Note in *J. Amer. Chem. Soc.,* **74,** 1612–15 (*March* 20, 1952).

Using Cl^{36} as a tracer the self-diffusion of chloride ion is determined at all except the very low concentrations employing again the capillary method. There is a very good theoretical discussion of results.

T. C. TOYE

532.72

7996. The Soret effect. C. C. TANNER. Letter in *Nature* [*Lond.*] **170,** 34–5 (*July* 5, 1952).

Soret coefficients of about $0{\cdot}1$–$0{\cdot}2\%$ per degree were found for dilute KCl and $BaCl_2$ solutions with an apparatus similar to that used previously [*Trans Faraday Soc.,* **23,** 75 (1927)]. Diffusion constants, derived from the separation-time curves, required to satisfy de Groot's equations were substantially independent of cell height and solution concentration and agreed with published values. R. H. DAVIES

532.72

7997. Interdiffusion of polyvinyl acetate with a series of solvents. A. T. Hutcheon, R. J. Kokes, J. L. Hoard and F. A. Long. *J. Chem. Phys.*, **20**, 1232–6 (*Aug.*, 1952).

The Lamm scale method has been used to follow the interdiffusion of polyvinyl acetate with ethyl acetate, propyl acetate, isopropyl acetate, butyl acetate and triacetin at 30°C, and with acetone at 20°, 30° and 40°C. For all these systems the mutual diffusion coefficient attains a maximum value at intermediate polymer concentrations. At a given concentration and temperature the $D(c)$ values are largest with acetone and much the smallest with triacetin, although the relative variation in $D(c)$ over the concentration range is actually largest with the latter. The general variation of $D(c)$ with concentration can be plausibly interpreted in terms of the mass flow-intrinsic diffusion concept introduced by Hartley. For the system acetone-polyvinyl acetate the calculated energy of activation for the diffusion is nearly constant at 1 kcal in the concentration range 0 to 40 grams polymer per 100 cc of solution but then rises rapidly to 10 kcal at 90 grams polymer per 100 cc. A.

532.73

7998. The theory of regular solutions. J. S. Rowlinson. *Proc. Roy. Soc. A*, **214**, 192–206 (*Aug.* 21, 1952).

The usual theory of regular solutions is modified. Each molecule is supposed to move near its site in a potential determined by the field of its nearest neighbours. The number of neighbours of each component is fixed by the quasi-chemical approximation. Four modifications are considered, which differ only in the way in which the free-volume of any molecule is supposed to depend on the nature of its neighbours. The first of these modifications gives the usual theory. The second and third are cases which have been considered by Ono [Abstr. 3154 (1951)] and by Prigogine and Garikian [Abstr. 5584 (1930)] respectively. The fourth is new, and is probably the most exact. It is shown that, for all modifications, the usual theory is unchanged, to a first approximation, if $\Delta = 1$, where $\Delta^2 = E_{AB}^2/(E_{AA}E_{BB})$, and E is the energy of interaction of an isolated pair of molecules. If $\Delta \neq 1$, then an important correction term is needed. The application of the most exact of these modified theories to the critical solution temperature is discussed. It is shown that, for molecules with similar energies of interaction, this theory gives the same relations between the properties of the solution and those of the components, as does the theory of conformal solutions, derived by Longuet-Higgins. A.

532.73 : 530.162 : 536.7

7999. Statistical thermodynamics of solutions of electrolytes and non-electrolytes. S. Ono. *Progr. Theor. Phys.*, **6**, 447–57 (*July–Aug.*, 1951).

The generalized Born–Green integral equations for solutions of electrolytes and non-electrolytes are derived according to the method previously shown [Abstr. 5643 (1951)]. The assumption of superposition for the potentials of average force of solute molecules or ions is employed throughout the present paper. The integral equations may be used, if the potentials of average force at infinite dilution are known, to compute the deviation from perfect solution behaviour. A.

532.77

8000. A remark on the hydrodynamical theory of the viscosity of solutions of macromolecules. N. Saitô. *J. Phys. Soc. Japan*, **7**, 447–50 (*Sept.–Oct.*, 1952).

The hydrodynamical problem of many particles interacting in a laminar flow is discussed on the basis of Stokes approximation. Two methods of approximation are introduced in order to derive the concentration dependence of the viscosity of solutions of rigid spheres. In any case an improper integral is involved which can be evaluated to be of different values according to different ways of integration. This physically absurd result comes from Stokes approximation. A new fundamental equation is proposed for the problems in a laminar flow from an analogous reasoning given by Oseen for the case of uniform flow. A.

532.77 : 535.32

8001. Determination of the solubility isotherm (at 13°C) for the system mercuric bromide/barium bromide/water. Study of the refractive index and dispersion of the solutions. M.-L. Delwaulle and J. Van Heems. *C.R. Acad. Sci.* [*Paris*] **235**, 161–3 (*July* 16, 1952) *In French.*

It has been found that the $HgBr_2/Br^-$ ratio can vary from 0 to 0·7, and that it is possible to obtain a solution having a very high concentration of either bromide. The refractive index increases regularly with the concentration of either, or both, bromides. The dispersion is a function of the refractive index, increasing irregularly as the index increases.

F. LACHMAN

532.782 : 541.128

8002. Theory of catalysis of nucleation by surface patches. D. Turnbull. Letter in *J. Chem. Phys.*, **20**, 1327 (*Aug.*, 1952).

The process of solidifying small supercooled liquid mercury and tin droplets, coated with various films, can sometimes be described by one nucleation frequency. For mercury coated with mercury laurate, but infected with patches of a decomposition product of the laurate, the fraction of solidified droplets approaches an asymptotic value $x<1$ with increasing time. Based on work by G. E. Kimball and G. M. Pound and V. K. La Mer (1952) relations are derived for the nucleation frequency, which give good agreement with experiment. The number of patches with radii bigger than a critical radius is also calculated. This mode of nucleation is athermal.

A. J. TAYLOR

MECHANICS OF GASES 533

533.1

8003. Some hypothetical gases. N. Inoue. Note in *J. Phys. Soc. Japan*, **7**, 119–21 (*Jan.–Feb.*, 1952).

Some of the hydrodynamical and cluster properties of hypothetical gases differing from real gases in 2 respects, *viz.* (1) the local velocity of sound in the gas, at rest, is 0, and (2) the value of γ, the ratio of the

pecific heats is $\neq 1{\cdot}405$ are discussed and tabulated nd compared with those of a mass of sand and of a erfectly plastic material. J. S. G. THOMAS

533.16 : 539.153

004. Difference in viscosity of ortho- and para-ydrogen at low temperatures. E. W. BECKER AND . STEHL. Letter in *Phys. Rev.*, **87**, 525 (*Aug.* 1, 1952). Normal hydrogen was compared with gas of vari-ble p–H_2 content. The viscosity difference was of pposite sign and only 0·1 the amount of Halpern and wathmey's measurements. J. JACOBS

533.6.011.5

005. Reflection of a wave at an interface of super-onic flows and wave patterns in a supersonic compound t. R. KAWAMURA. *J. Phys. Soc. Japan*, **7**, 482–5 (*Sept.–Oct.*, 1952).

In the first half the behaviour on reflection of a weak incident wave at an interface of two supersonic lows is studied. The weakness of the incident wave nakes it possible to use the isentropic characteristic heory with good approximation and, as a result, omplication in the analysis is greatly reduced. It is ound in this study that under a certain condition the wave reflected from a compression (or expansion) ncidence is an expansion (or compression). The ondition is given as a function of the Mach numbers f the flows and the ratios of the specific heats. In he latter half, similar treatment is applied to the nalysis of wave patterns in a supersonic compound et. The treatment of the problem in flow deflection nd pressure plane simplifies the analysis greatly. It becomes clear in this study that there are two different types of wave pattern in the jet. In the one, pressure is oscillatory in the jet and in the other non-oscillatory. The conditions which discriminate both cases are also obtained. A.

533.6.011.5

8006. On the detached shock wave in front of a body of revolution moving with supersonic speeds. T. KAWAMURA. *J. Phys. Soc. Japan*, **7**, 486–8 (*Sept.–Oct.*, 1952).

The uniform supersonic flow past a body of revolution with a finite radius of curvature at its nose is studied. Various hydrodynamical quantities are expanded in power series of the coordinates in the neighbourhood of the stagnation point of the body. The coefficients of the series are determined by the boundary conditions at the surface of the body as well as by the shock wave conditions at the shock wave. A.

533.6.013.22

8007. Some remarks on the Lagrangian correlation coefficient of turbulent diffusion in a wind tunnel flow. E. INOUE. *J. Phys. Soc. Japan*, **7**, 503–7 (*Sept.–Oct.*, 1952).

Many influences of physical, chemical and geometrical properties of the diffused substances on the Lagrangian correlation coefficient for the turbulent diffusion in a wind tunnel flow are considered theoretically. Influences of the decaying phenomena of a wind tunnel turbulence are also taken into consideration. Influences of these factors on the Lagrangian smallest eddy λ_η introduced by G. I. Taylor are discussed in detail making use of the concept of the smallest turbulon $\Lambda_\infty \sim \nu^{3/4}\varepsilon^{-1/4}$ due to the similarity theory of turbulence, where ν and ε mean the kinematic viscosity of a fluid material and the dissipation rate of turbulon energy respectively. A.

533.6.013.22

8008. On the equations of the decay of isotropic turbulence in magneto-hydrodynamics. M. Z. E. KRZYWOBLOCKI. *J. Phys. Soc. Japan*, **7**, 511–12 (*Sept.–Oct.*, 1952).

On the basis of his previous works [Abstr. 2379, 6019 (1949), 1509 (1952)] the author derives the equations of the decay of istropic turbulence in magneto-turbulence in compressible media. All the random variables fulfil the requirements of isotropy and homogeneity and are dependent. A.

533.6.07

8009. Contribution to the study of the flow of compressible fluids. M. PLAN. *J. Rech. Cent. Nat. Rech. Sci.*, **4**, 187–8 (*June*, 1952) *In French.*

Brief particulars are given of the high speed wind tunnel installed at the C.N.R.S. and 24 illustrations are given of characteristics of the flow, shock waves, jet lines, and reflection of waves at the tunnel walls, produced by the flow of gas past spheres of dia. 9·5, 10·4 and 14·0 mm, and past cylinders of dia. 2, 4, 6, 8 and 10 min. J. S. G. THOMAS

533.6.08

8010. Influences of the length of hot-wire anemometer on the measurement of turbulent flow. E. INOUE. *J. Phys. Soc. Japan*, **7**, 508–10 (*Sept.–Oct.*, 1952).

Making use of informations on the fine structure of turbulence due to the modern similarity theory, influences of hot-wire length or instrumental sensitivity on measurement of G. I. Taylor's smallest eddy in a turbulent fluid are dealt with theoretically in this paper. It is assumed that the hot-wire anemometer of length L cuts off the contribution of turbulons (turbulence elements) smaller than L, and the result is obtained that the practically measured diameter of the effective smallest eddy is in proportion to $L^{2/3}$, provided L is slightly greater than the smallest turbulon length given by $\nu^{3/4}\,\varepsilon^{-1/4}$, where ν and ε denote the kinematic viscosity of the fluid and the mass rate of turbulent dissipation respectively. A.

MOLECULAR THEORY OF GASES 533.7

533.7 : 536.423.4

Point of condensation and the volume dependency of the cluster integrals. *See Abstr.* 8120

533.7 : 537.56

8011. On particle distribution in all non-uniformly heated completely ionized gas. A. A. ABRIKOSOV. *Zh. Eksper. Teor. Fiz.*, **22**, 310–20 (*No.* 3, 1952) *In Russian.*

In surveying the general position of research work in this line, the author states that a general formula for the coefficient of thermo-diffusion has been evolved, the electrical and thermal conductivity of completely ionized gases was investigated by Cowling [Abstr. 2301 (1945)], Landshoff [Abstr. 794 (1950)] and, by a

somewhat different method, by Cohen, *et al.* [Abstr. 1059 (1951)], but the question of the thermo-diffusion in ionized gases has not yet been investigated at all, notwithstanding the interest which it should create in view of the fact that this phenomenon can actually occur in nature and can, in particular, play a significant part in the formation of the stars. The author's object is to contribute to the filling of this gap. In this paper the investigation is restricted to the case of a complete ionization. The analysis is based on the Boltzman kinetic equations set for a mixture of two material gases and the electron gas, with Coulomb forces and thermo-electric forces acting between the particles in addition to the forces arising from the impacts between them. In order to evolve the coefficient of thermo-diffusion, a stationary solution of the system of these equations is sought on the assumption that the distribution function does not differ appreciably from the Maxwell equilibrium distribution, omitting the terms of higher order of magnitude, and using the simplifications which the symmetry of the distribution of impacts allows. Two important artifices are used for the solution of the equations thus transformed:—the development into the Sonine–Laguerre polynomes and the limitation of the volume of integration by the Debye radius, which arises from the screening effect of the intermediate electrons. The solution of the equations thus obtained allows to determine the coefficient of thermo-diffusion by calculating the flow of one of the gases. The final formulae are, however, very cumbersome and the calculations are very laborious. The author gives the results of the first approximation, in a general case, and of the second approximation in two limiting cases. N. S. JAPOLSKY

533.7 : 537.56

8012. The influence of thermal ionization upon particle distribution in an unevenly heated gas. A. A. ABRIKOSOV. *Zh. Eksper. Teor. Fiz.*, **22,** 321–30 (*No.* 3, 1952) *In Russian.*

Continuation of the author's previous paper (preceding abstract) in which the case of a completely ionized gas was considered. The analysis is now extended to a still more complex case where the ionization is incomplete. In the first place, a mixture of gases with different degrees of ionization of atoms, but not containing completely neutral atoms, is considered. The analysis begins from the statement of the formula determining the equilibrium ratio between the numbers of differently ionized atoms. It is then pointed out that the basic equations are analogous to those obtained in the previous paper, and into these relationships the formula for the equilibrium ratio is introduced, using, for the sake of simplification, the fact that the ionization energy levels on which this equilibrium ratio largely depends, are so far distant for different gases that each gas can be considered separately as a mixture of two ionized components. However, even with this simplification, the mathematics proves to be too laborious for expounding, and therefore further consideration is restricted to the case where the concentration of one of the components is relatively very small. Even then the results prove to be rather laborious. The most interesting implication of these results is that the ions with smaller charge may diffuse into the regions with higher temperature, giving thus rise to a negative coefficient of diffusion. In the case of isotopes, this may lead to the concentration of lighter isotopes in regions of higher temperature, which is opposite to the usually observed direction. Furthermore, the ionization can increase many times the value of the coefficient of thermal diffusion. The analysis is then extended to the case where the neutral atoms are also present in the mixture. Since the law of interaction between neutral atoms, especially at high temperatures, is not known, a simple assumption is made that the interaction between the neutral atoms, and the interaction between neutral and ionized atoms, can be reduced to impacts between elastic balls of certain effective radii. In conclusion, graphs are given for the coefficient of diffusion in the mixtures of He^3 and He^4, and of B^{10} and Pb^{208}, as functions of temperature, at different set pressures, calculated from the author's formulae. The graphs contain a number of maxima and minima. The signs at the latter are negative. N. S. JAPOLSKY

533.73

8013. The second virial coefficient of benzene. P. G. FRANCIS, M. L. MCGLASHAN, S. D. HAMANN AND J. MCMANAMEY. Letter in *J. Chem. Phys.*, **20,** 1341 (*Aug.*, 1952).

The results of 2 independent series of measurements conducted by 2 teams of investigators with 3 benzene samples lie, when plotted in the diagram, close to the curve $B/\text{cm}^3\text{mole}^{-1} = 70 - 13\cdot2\times10^7/T^2$, selected by Everett and Penney. F. LACHMAN

533.75 : 536.71

A new equation of state for gases. *See Abstr.* 8148

VIBRATIONS . ACOUSTICS 534

534.1

8014. Evaluation of free vibrations in accordance with the Maxwellian theory. E. KLEIN AND E. JENCKEL. *Z. Naturforsch.*, **7a,** 305–13 (*May*, 1952) *In German.*

Derives differential equations for the free vibration of different Maxwellian bodies. Gives solutions for these equations, and for the logarithmic decrement. Discusses the evaluation of free vibrations by means of the complex E modulus. The theoretical treatment of the recoil elasticity is based on the free vibrations of Maxwellian bodies. F. LACHMAN

534.134 : 538.565.5 : 621.3.018

8015. On electric and acoustic transient phenomena. H. DÄNZER. *Ann. Phys.* [*Lpz.*] **10,** 395–412 (*No.* 6–7, 1952) *In German.*

The theoretical investigation described is based on the experimental observations of F. Trendelenberg, F. Thienbaus and E. Franz [*Akust. Z.*, **1,** 59 (1936); **3,** 7 (1938)] on the build-up of vibrations in organ pipes. The initial phenomena involved in the build-up of oscillations by feedback (reaction) in electrical and acoustic waveguides is investigated mathematically. A comparison is made between the electrical case of an oscillating valve with inductively coupled grid

nd anode circuits, feeding oscillatory current into a line," and the acoustic case of flue and reed organ ipes. A. B. WOOD

534.141.4

016. Observations on edge-tones. M. MOKHTAR ND H. YOUSSEF. *Acustica*, **2**, 135–9 (*No.* 3, 1952).

The mechanism of edge-tones is studied from the ollowing aspects: (1) the distribution of wind velocity etween slit and edge; (2) the paths of the vortices; 3) the velocity: frequency relation. Particular ttention is paid to the regimes that exist just before nd after a transition to an edge-tone of higher order. A.

534.151 : 534.372

017. A torsion pendulum of improved design for measuring damping capacity. J. W. JENSEN. *Rev. Sci. Instrum.*, **23**, 397–401 (*Aug.*, 1952).

A pendulum with an improved method of alignment and minimized friction losses is described. An optical recording system is employed, using a moving film camera with film velocity variable from 1 in/hr to 60 in/sec to record amplitude decay of freely vibrating specimens. Simplicity of operation permits semi-skilled personnel to obtain 6 to 10 records per hour of high damping Mn–Cu specimens. Sample records demonstrate how variations from 0·002% to over 33% in damping capacity may be measured at torsional stresses ranging from several hundred to about 20 000 lb/in.^{2} A.

534.154

3018. An acoustical method of vibration measurement. V. N. FEDOROVICH. *Zh. Tekh. Fiz.*, **22**, 238–44 (*No.* 2, 1952) *In Russian.*

The instrument for measuring vibrations in machines, etc., described, consists of a wool-filled tubular probe feeding into an infinite load and fitted at one side with a condenser microphone, with the latter's diaphragm parallel to the axis of the tube. Expressions are derived for the theoretical response of the vibrometer, its calibration, and maximum error (shown not to exceed 1·2 db at 10^4 c/s). Results of measurements over the range of 100–4000 c/s show good agreement with theory. A. GELBTUCH

534.222.1

3019. On the transmission of sound waves across boundaries of solid and liquid media. B. D. TARTAKOVSKIĬ. *Zh. Tekh. Fiz.*, **21**, 1194–201 (*No.* 10, 1951) *In Russian.*

Theoretical. Using a method similar to the classical treatment of plane sound-wave transmission across a plane solid-to-solid interface, a detailed examination is made of the special case when, for one of the media, the Lamé const. $\mu = 0$ (characteristic of the liquid state). Expressions for the energy transmission and reflection coefficients are derived for (*a*) a sound wave in a liquid incident upon a solid boundary; (*b*) a sound wave in a solid incident upon a liquid; (*c*) propagation of a sound wave through a solid plate immersed in a liquid. Values of these coefficients are presented graphically for case (*a*) over the range of Poisson's ratio = 0·2 to 0·5, covering all angles of incidence from normal to grazing. A. SCHOFIELD

534.222.2 : 534.154 : 537.523.3

8020. Determination of pressure-time curves of the shock wave by a new method. C. O. CRIBORN. *Appl. Sci. Res. A*, **3**, 225–36 (*No.* 3, 1952).

An experimental technique is described, which is based on the dependence upon air pressure of the corona discharge current between a positively charged ring and a pointed probe on its axis. A ring approx. 6 mm dia. at 3–4 kV gives a discharge current of 50–100 μA when the pressure is 1 atm., falling to 10 μA at 2 atm.; the time variation of current is recorded on an oscillograph, and hence the pressure variation may be deduced from previous static calibration. The method is capable of accurate measurement of pressures as low as 0·01 atm., and is not very sensitive to changes in atmospheric temp. or humidity. Advantages claimed for this technique are (*a*) freedom from shock reflection at the measuring surface ensures direct measurement of static pressure; (*b*) unimportance of natural gauge oscillations; (*c*) the dimensions of the gauge can be kept small. A. SCHOFIELD

534.222.2 : 537.523.3

8021. Explosion wave oscillography by means of corona probes. H. OERTEL. *Z. angew. Phys.*, **4**, 177–83 (*No.* 5, 1952) *In German.*

A detailed account of the study of the propagation of intense sound and shock waves with various forms of corona discharges, whose electrical characteristics vary when explosion waves pass through them. Oscillographic records are shown and details of several applications in this field are given. The relevant data for certain types of corona discharge are also given in considerable detail. J. D. CRAGGS

534.23

8022. General theory of sound absorption in gases and liquids, taking into account transport phenomena. J. MEIXNER. *Acustica*, **2**, 101–9 (*No.* 3, 1952) *In German.*

The author computes the complex velocity of sound —and hence the absorption and the dispersion of sound—for an arbitrary fluid medium in which internal transformations take place, including the contribution of transport phenomena (conduction of heat, diffusion, thermodiffusion and fluid friction). The application of the thermodynamical theory of irreversible processes permits the derivation of general results without undertaking to exemplify the special nature of the internal transformations. Apart from the relaxation time, all the quantities determining the complex velocity of sound are thermodynamical ones. One can find them for a special problem from an appropriate model using the methods of statistical mechanics. With good approximation sound absorption due to transport phenomena may be added to that due to internal transformation in the whole frequency range. With respect to sound absorption by internal transformation only there are eight diverse but equivalent equations, from which all known results can be derived in a simple way. A.

534.23 : 541.14 : 578.088.2

8023. Biological and chemical processes in a field of ultrasonic waves. I. E. ELPINER. *Zh. Tekh. Fiz.*, **21**, 1205–12 (*No.* 10, 1951) *In Russian.*

Blood serum, dealbumenized by heating before and

after exposure to ultrasonic vibrations (frequency 600 kc/s, intensity 5–10 W/cm²), was polarographically analysed. An increase in concentration of thermally-stable albumen of low mol. wt. was revealed, which is attributed to disruption of albumen molecules into their loosely-connected constituent globules. An analogous molecular dissociation was likewise produced in a variety of amino-acids, those containing a cyclic structure (e.g. tirosine, histidine) being most readily broken down. It is shown that frictional forces between macromolecules and the liquids in which they are suspended can exceed the bond strength for C–C, C–O, and C=C bonds, so that macromolecular disruption can be explained on this purely mechanical basis. In simpler molecules this is not so. Investigation of the auto oxidation of KI in aqueous solution by an ultrasonic beam showed that oxidation occurs most readily in dilute solution; it is suggested that in this case oxidizing radicals are produced in cavitation bubbles as a result of the high electric potentials generated at the liquid-vapour interface. A. SCHOFIELD

534.23 : 548.5

Crystallization of organic substances under the influence of ultrasonic waves. *See Abstr.* 8550

534.232

8024. Longitudinal magnetostrictive ultrasonic generation using cross-magnetization. H. H. RUST AND E. BAILITIS. *Acustica*, **2**, 132–5 (*No.* 3, 1952) *In German.*

To obtain larger amplitudes of motion with ultrasonic generators employing the longitudinal magnetostrictive effect, it is suggested that the transverse magnetostrictive effect be used also. That can be achieved by non-simultaneously cross-exciting the magnetostrictive transducer, thereby successively inducing field vectors normal to each other. Two sets of coils are used, their axes arranged at right angles to each other. A set consists of two coils, carrying direct and alternating current, respectively. The remanence-conditioned loss of amplitude can be regained with the cross-magnetization. On rotating the magnetic vectors of ferromagnetic domains to a rectangular position in relation to the wave vector, remanence will vanish in this direction, while remanence evidently is preserved on a complete 180° reversal. A.

534.26

8025. The edge condition in the theory of diffraction of elastic waves. A.-W. MAUE. *Z. Naturforsch.*, **7a**, 387–9 (*June*, 1952) *In German.*

The precise nature of the singularity at a sharp edge is investigated, by studying an elastic wave in the neighbourhood of the edge of a single diffracting screen. As the edge is approached, stresses and strains must be of the order of the reciprocal square root of the distance from the edge. The theory applies to wave motion near the edge of a crack in an elastic medium. J. G. OLDROYD

534.6 : 621.317.755 : 621.317.39

8026. Composite cathode ray oscillograph displays of acoustic phenomena and their interpretation. T. SOMERVILLE AND C. L. S. GILFORD. *B.B.C. Quart.*, **7**, 1–13 (*No.* 1, 1952).

Describes a method of measuring reverberation, etc., which is an improvement on the Neumann high-speed sound level recorder of 1935 in that a much higher writing speed is obtainable. Reverberation times below 0·1 sec have been measured. Successive traces of a logarithmically decaying pulse on a c.r.t. are photographed on a film which is moved by a synchronous motor. Reference frequencies are marked at intervals by a trace brightening. The method produces a three dimensional picture, in appearance similar to an oblique view of a mountain range. They are termed "pulsed glide displays." The equipment is illustrated with photos and block diagrams. The effects of low and high frequency formations are analysed, but it is pointed out that there are still difficulties in the detailed interpretation of the displays. B. B. AUSTIN (R)

534.6 : 621.395.6

8027. Design and analysis of subjective acoustical experiments which involve a quantal response. D. L. RICHARDS. *Acustica*, **2**, 83–91 (*No.* 2, 1952).

Subjective acoustical measurements involve quantities which do not possess an intrinsic scale of magnitude and so the only observations possible are in the form of very simple classification judgments or quantal responses. These measurements are usually also concerned with relating the subjective response to some objective, physically measurable stimulus. Much of the methodology developed in the broader field of biological experimentation is surprisingly appropriate to these problems. Some examples are given of the application of "probit analysis" and "analysis of variance" to the measurement of telephone circuits. These statistical methods used with appropriate designs of experiments not only yield valid confidence intervals but also point to the most efficient method of conducting the measurements through separation of the several sources of variation. A.

534.61

8028. Contributions to ultrasonic measurement technique in liquids. J. KOPPELMANN. *Acustica*, **2**, 92–5 (*No.* 2, 1952) *In German.*

The first part describes a new form of microphone for point-to-point probing of ultrasonic fields in liquids at frequencies above 100 kc/s. The second part is concerned, as an extension to the previous work of Hertz and Mende (1939), with the conditions for Langevin's formula for acoustic radiation pressure. It is shown that the introduction of the ultrasonic generator causes the density of the liquid in the sound beam to rise, following on the inflow of liquid from outside into the sound beam. A

534.612

8029. Procedure for the absolute measurement of the acoustic pressure of an ultrasonic flux in a liquid using the radiation pressure on a liquid-gas interface. C. FLORISSON. *C.R. Acad. Sci.* [*Paris*] **235**, 27–8 (*July* 7, 1952) *In French.*

The radiation pressure on the lower surface of an air cell submerged in the liquid is obtained by counterbalancing the upward force by weights, to restore equilibrium when an oscillator mounted beneath the cell is energized. The absolute pressure is calculated and a calibration of the oscillator obtained. G. F. HODSMAN

534.612.4 : 621.317.39.089.6 : 621.395.616

8030. A simplified technique for the pressure calibration of condenser microphones by the reciprocity method. A. K. NIELSEN. *Acustica*, **2**, 112–18 (*No.* 3, 1952).

The usual reciprocity procedure for the pressure calibration of condenser microphones is reviewed. It is pointed out that the measuring technique is usually based on the measurement of voltage ratios and electrical impedances apart from such fixed quantities as polarizing voltage, mechanical dimensions, etc. It is shown in the paper that the reciprocity calibration procedure is simplified if the concept of transfer impedance is used directly, i.e. the ratio of output voltage of the microphone to input current in the source transducer is measured and not the ratio of output voltage to input voltage. The substitution method of measuring the open-circuit voltage of a microphone with a high electrical impedance is avoided in favour of a direct measurement using a suitable circuit. The noise performance of a normal triode amplifier and a cathode-follower is compared, and it is concluded that for measurement purposes it may sometimes be advantageous to use a circuit with a higher noise level in order to obtain e.g. a lower resistance value of the grid leak. A.

534.7 : 612.85

Physiological acoustics. Hearing. *See Abstr.* 8611

534.773 : 389.6 : 621.395.92

8031. The problem of the standardization of hearing aid apparatus and methods of measurement. P. CHAVASSE AND R. LEHMANN. *Acustica*, **2**, 119–31 (*No.* 3, 1952) *In French.*

Discusses the standardization of the receiver, both for bone conduction and normal listening, outlines the historical development of the methods used, especially those used in the Acoustics Department of the C.N.E.T., and then reviews the problem of the calibration of the complete deaf-aid apparatus. After giving in detail a number of propositions concerning the standardization of the acoustic methods of measurement for apparatus for air-conduction, the authors outline a project for specifying apparatus of the deaf-aid type, satisfactory in most cases of deafness. They finally emphasize the need for the collaboration of mixed teams of medical and electro-acoustical scientists in this work. A.

OPTICS . RADIATION . SPECTRA 535

535.1 : 536.7 : 538.566.2

8032. On Helmholtz's principle of optical reversibility. C. P. TINGWALDT. *Optik*, **9**, 248–53 (*No.* 6, 1952) *In German.*

Fragstein has shown [Abstr. 6332, 8650 (1950)] that Planck's formulation of this principle is inapplicable to absorbing media and that the energy density in such media is a function of the complex refractive index. This fact is used to show that the principle is valid if the two points between which the reversibility is postulated are in thermodynamic equilibrium. In this form, the principle applies also to entropy radiation and to the transmission of long electromagnetic (radio) waves if the distance between the two points is large as compared with the wavelength of radiation. R. A. WEALE

535.241

8033. Limiting distance for photometric measurements [on projectors]. O. REEB. *Optik*, **9**, 254–73 (*No.* 6, 1952) *In German.*

Derives the formulae for the axial distances at which a parabolic mirror becomes just fully flashed when the source, at the focus, is a line, a sphere or a disk. This distance becomes infinity for a disk source if the edge of the mirror is in the plane of the disk. The author points out that this "optical" limiting distance is not necessarily the same as the "photometric" limiting distance, i.e. that at which the value of illumination gives the luminous intensity of the projector to an assigned accuracy. He derives relationships between the two distances for the three sources considered. J. W. T. WALSH

535.247.4 : 535.6

8034. Correction of the spectral sensitivity of a photocell for heterochromatic photometry and colorimetry. J. TERRIEN. *Comm. Int. Eclair.* [*CIE*] 12*th Mtg* (1951). *Volume* 2, *Paper Ii*, 4 *pp.* (1952) *In French.*

Describes apparatus in which the spectral sensitivity of a photocell with good linearity is corrected by means of a dispersion and template system, but the dispersion is provided by an interference filter instead of by a prism or grating. Partial correction is obtained with a colour filter so that the template shape is not as critical as it would be if providing the whole of the correction. J. W. T. WALSH

535.31 : 535.323

8035. Material problems in optical calculations. H. SCHULZ. *Z. wiss. Photogr.*, **47**, 65–71 (*No.* 4–6, 1952) *In German.*

The Hartmann formula for the variation of refractive index with wavelength is applied to the new rare earth glasses and to some plastics. The constants, when plotted as a function of refractive index, demonstrate the departure of these materials from earlier types. A method of obtaining the powers of the components of an achromatic doublet is given. The temperature coefficients of an achromatic doublet made from plastic materials are discussed. R. W. FISH

535.317 : 535.832

8036. The astigmatism of spherical spectacle lenses and point-focal imagery. H. JENSEN. *Optik*, **9**, 193–205 (*No.* 5, 1952) *In German.*

An account is given of the "best form" or point-focal lenses giving freedom from astigmatism over a wide field. It is shown that these cannot be completely free from such astigmatism over the complete field of view, for all object distances or for all zones of the lens. The residuals need to be computed by ray tracing. R. W. FISH

535.317 : 621.397.6

8037. A 5 : 1 television zoom lens. H. H. HOPKINS. *Proc. Instn Elect. Engrs, Pt III A*, **99**, 109–12, 174–8 (*No.* 17, 1952).

For abstract, see Abstr. 6367 (1952).

535.317.1

8038. Application of a laminar medium to the focusing of waves. A. L. MIKAELYAN. *Dokl. Akad. Nauk SSSR*, **81**, 569–71 (*No.* 4, 1951) *In Russian.*

A law is developed governing a continuous variation of the refractive index in a medium along the *Y*-axis, so that cylindrical waves emitted by a linear source arranged in the OZ direction reach the plane $x = x_0$ with a plane wave-front. F. LACHMAN

535.317.5

8039. A note on Berek's isoplanatic criterion. J. FOCKE. *Optik*, **9**, 243–7 (*No.* 6, 1952) *In German.*

The accuracy required for the application of the isoplanatic criterion for freedom from asymmetric aberrations is discussed and it is shown that it does not always give an accurate determination of the diaphragm position. Alternative forms of the criterion are investigated. A graphical method allows the position of the diaphragm to be determined with sufficient precision for practical design. R. W. FISH

535.317.6

8040. The fine correction of optical systems. F. I. HAVLIČEK. *Optik*, **9**, 333–4 (*No.* 7, 1952) *In German.*

Equations are given which allow the effect of a small change of radius of any surface of an optical system to be calculated. R. W. FISH

535.323 : 535.345 : 535.39

8041. Optical properties of metallic alloys in the infrared spectral region. A. V. SOKOLOV AND V. I. CHEREPANOV. *Zh. Eksper. Teor. Fiz.*, **22**, 493–8 (*No.* 4, 1952) *In Russian.*

It is shown that the refractive and absorption indices, as well as the reflective and emissive capacities of partly-ordered metallic alloys in the long-wave part of the spectrum are functions not only of the concentration but also of the degree of the long-range order, which should cause ordering anomalies of optical properties. Calculated values of the coefficient of reflection for brass (ordering temperature = *c.* 753°K) are tabulated and graphed for the range 700–770°K. F. LACHMAN

535.324

8042. Photometric determination of refractive index. H.-J. HELWIG. *Comm. Int. Eclair.* [*CIE*] *12th Mtg*, 1951. *Volume* 2, *Paper Oo*, 3 *pp.* (1952) *In German.*

The illumination of a surface is greater in an optically dense medium than it is in air and the author shows how, from measurements of the luminance of a diffusing plate, first in air and then when forming the second boundary surface of a liquid, the refractive index of the liquid can be calculated. J. W. T. WALSH

535.33.07 : 535.5

8043. Method of controlling λ/4 plates. V. V. KARASEV. *Zh. Tekh. Fiz.*, **22**, 616–19 (*No.* 4, 1952) *In Russian.*

A great accuracy is required of λ/4 plates used in polarizing spectrometers, especially when used for measuring the thickness of thin films. In this case the limits of errors must be as narrow as 0·1–0·2%. The test set-up described uses a rotating polarizer and low-voltage photo-electron multiplier of Timofeev's type, and a c.r.o. as indicating instrument. Generally, elliptical polarization is produced which (by secondary modulation) gives a straight line of varying length on the c.r.o. screen, but for precise λ/4 plates, free of dichroism, the polarization is circular, this leaving the rotating polarizer and electron multiplier unaffected (no secondary modulation taking place) and the image on the screen becomes a straight line of constant length. B. F. KRAUS

535.33.07 : 535.65

8044. The spectrophotometry of light sources. S. T. HENDERSON AND M. B. HALSTEAD. *Brit. J. Appl. Phys.*, **3**, 255–9 (*Aug.*, 1952).

The calibration and use of simple, non-automatic equipment for spectrophotometry of light sources is described, with particular attention to precautions required for accuracy. The computation of chromaticity from the spectral energy distribution curves is illustrated, with results for a variety of lamps. These results show better agreement with visual colorimetry than in other recently published work. The change of chromaticity of fluorescent lamps with varied loading is analysed by the same methods, and the application to the study of phosphors briefly mentioned. A.

535.33.07 : 536.483

An optical cell for use with liquid helium. *See Abstr.* 8141

535.331

8045. The spectroscopy of the solid state: copper and chromium. E. M. GYORGY AND G. G. HARVEY. *Phys. Rev.*, **87**, 861–2 (*Sept.* 1, 1952).

The M_{23} emission curves of Cu and Cr have been obtained by using a vacuum recording spectrograph. A.

535.338 : 537.525.8

8046. On the occurrence of complex fragments (polyatomic radicals?) in glow discharges through benzol derivatives. I. On the "V spectrum" of the benzol monoderivatives. H. SCHÜLER, L. REINEBECK AND R. KÖBERLE. *Z. Naturforsch.*, **7a**, 421–7 (*June*, 1952) *In German.*

A study of certain emission spectra which are produced in l.p. glow discharges in certain organic vapours (some 25 molecules are listed in the paper). These spectra are attributed to complex radicals of the form C_6H_5, C_6H_5–C, or C_6H_5–CH_2. Representative spectrograms taken with isopropylbenzol and benzylcyanide are reproduced. J. D. CRAGGS

535.338 : 537.525.8

8047. On the occurrence of complex fragments (polyatomic radicals?) in glow discharges through benzol derivatives. II. On the occurrence of fragment emissions in disubstituted benzol. H. SCHÜLER, L. REINEBECK AND R. KÖBERLE. *Z. Naturforsch.*, **7a**, 428–31 (*June*, 1952) *In German.*

Continues the work described in the previous paper, but with special attention to p-, o- and m-xylol and certain more complex molecules. Further spectra are reproduced and discussed. J. D. CRAGGS

535.338.3

8048. Multiplet intensities for the lines $^4S - {}^2D$ of S II, O II, and N I. R. H. GARSTANG. *Astrophys. J.*, **115**, 506–8 (*May*, 1952).

The transition probabilities and intensity ratio of

he doublet $^4S - {}^2D$ of S II are computed, including he effect of spin-spin interaction. Revised transition robabilities and intensity ratios are also given for he $^4S - {}^2D$ doublets of N I and O II. A.

535.338.332

8049. Structure of the line λ4686 of He II. K. MURAKAWA AND S. SUWA. *J. Phys. Soc. Japan*, **7**, 67–9 (*Sept.–Oct.*, 1952).

The fine structure of the line He II λ4686 was measured, and it was found that the shift of the $3S$ term relative to the $3^2P_{1/2}$ term is $0{\cdot}135 \pm 0{\cdot}005$ cm^{-1}. This is to be compared with the calculated value $0{\cdot}138 \pm 0{\cdot}001$ cm^{-1}. That of the $4S$ term was found to be $0{\cdot}056 \pm 0{\cdot}009$ cm^{-1}, the calculated value being $0{\cdot}0584 \pm 0{\cdot}0005$ cm^{-1}. A.

535.338.332

8050. Hyperfine structure in the spectra of iridium and osmium. K. MURAKAWA AND S. SUWA. *Phys. Rev.*, **87**, 1048–9 (*Sept.* 15, 1952).

The hyperfine structure in the spectra of Ir I and Os I was studied and the following results were obtained. (1) Both Ir^{191} and Ir^{193} have nuclear spins $\frac{3}{2}$, and the ratio of their magnetic moments is $\mu^{193}/\mu^{191} = 1{\cdot}04 \pm 0{\cdot}04$, with $\mu^{193} = +0{\cdot}17 \pm 0{\cdot}03$ nm. Their quadrupole moments are given by $Q^{193} = (+1{\cdot}0 \pm 0{\cdot}5) \times 10^{-24}$ cm^2 and $Q^{191}/Q^{193} = 1{\cdot}2 \pm 0{\cdot}4$. Lines due to the transition $d^7s^2 - d^7sp$ were observed to have an isotope displacement effect of the order of $0{\cdot}063$–$0{\cdot}071$ cm^{-1}. (2) Os^{189} has a nuclear spin $\frac{3}{2}$, a nuclear magnetic moment $+0{\cdot}70 \pm 0{\cdot}09$ n.m. and a quadrupole moment $(+2{\cdot}0 \pm 0{\cdot}8) \times 10^{-24}$ cm^2. A.

535.338.332 : 539.152.2

8051. Hyperfine structure in the spectrum of Pd I and the nuclear moments of Pd^{105}. A. STEUDEL. *Z. Phys.*, **132**, 429–45 (*No.* 4, 1952) *In German.*

A Fabry–Pérot interferometer was used. The spin of Pd^{105} is probably 5/2, its magnetic moment $-0{\cdot}57 \pm 0{\cdot}05$ n.m. Isotope displacements ($\lambda =$ 7961 and 8133 Å): $Pd^{108} - Pd^{110} = (29{\cdot}8 \pm 2{\cdot}5)10^{-3}$ cm^{-1}, $Pd^{106} - Pd^{110} = (65{\cdot}2 \pm 3{\cdot}5)10^{-3}$ cm^{-1}. The centres of the lines at 3405 and 3490 Å in odd isotopes are displaced by $(21 \pm 4)10^{-3}$ cm^{-1} with respect to those of even isotopes. L. PINCHERLE

535.338.333

8052. Isotope shifts in erbium. L. WILETS AND L. C. BRADLEY, III. *Phys. Rev.*, **87**, 1018–22 (*Sept.* 15, 1952).

An investigation of the Er isotope shifts has been conducted in the region between 4000 and 7000 Å using the dispersion of a Fabry–Perot interferometer crossed with a Steinheil three-prism glass spectrograph. Structures were measured in 68 lines, and components due to the even isotopes Er^{166}, Er^{168} and Er^{170} have been identified. The ratio of the isotope shifts $(\nu_{168} - \nu_{170})/(\nu_{166} - \nu_{168})$ is close to unity in nearly all lines measured, and it is concluded that the undisturbed value of the ratio probably does not differ from unity by more than 4%. Electron configurations have been proposed to describe the observed shifts, and in particular those lines, in which the component due to Er^{170} is shifted to larger wave numbers than the components due to the other even isotopes, probably arise from the two-electron transitions $4f^{11}6s6p$ to $4f^{11}5d^2$. A.

535.338.4

8053. Band spectrum of AsH. S. M. NAUDÉ AND T. J. HUGO. Letter in *Nature* [*Lond.*] **170**, 289–90 (*Aug.* 16, 1952).

The bands reported by Kimball and Bates (*Nature* [*Lond.*] **128**, 969 (1931)) probably arise from CH, not AsH. R. F. BARROW

535.343–15

8054. The rotation-vibration spectra of allene and allene-d_4. R. C. LORD AND P. VENKATESWARLU. *J. Chem. Phys.*, **20**, 1237–47 (*Aug.*, 1952).

The i.r. absorption spectra of allene and allene-d_4 vapour have been measured over the spectral range 250–5000 cm^{-1} with a prism spectrometer. The i.r. data, together with previously obtained Raman spectra, enable a complete vibrational analysis that satisfies the product rule well for all vibrational species. The torsional vibration is located at 865 cm^{-1} in allene and 615 cm^{-1} in allene-d_4. Fine structure was resolved for all perpendicular fundamental bands except that of the lowest frequency in both compounds. With help of the zeta-sum rule, a modified equation of H. H. Nielsen and the statistical weights of the rotational levels, the fine structure is analysed to yield a complete set of zeta-values for both molecules and a moderately accurate value for the moment of inertia about the figure axis. The latter gives for the HCH angle the figure 113° ± 1° if one assumes a C — H distance of 1·071 Å. A.

535.343–15

8055. The infrared spectrum of methyltrichlorosilane. L. BURNELLE AND J. DUCHESNE. Letter in *J. Chem. Phys.*, **20**, 1324 (*Aug.*, 1952).

Measurements in the gaseous and dissolved state give bands assigned to the vibrations of the point group C_{3v}, agreeing with the Raman frequencies of Shimanouchi, Tsuchiya and Mikawa [Abstr. 975 (1951)]. C. TURNER

535.343–32

8056. The near ultra-violet absorption spectrum of toluene. S. N. GARG. Letter in *J. Sci. Industr. Res.*, **11B**, 200–2 (*May*, 1952).

The new bands, reported by Padhye [Abstr. 2328 (1950)], are due to benzaldehyde. A table is given of new absorption bands between 70°C and 100°C. C. TURNER

535.343.2

8057. Color centers in fused quartz. R. YOKOTA. *J. Phys. Soc. Japan*, **7**, 316–21 (*May–June*, 1952).

It is found that in fused quartz made in reducing condition 3 absorption bands having peaks at 2·3, 4·1 and 5·6 eV, and in fused quartz made in oxidizing condition 2 absorption bands having peaks at 4·1 and 5·6 eV are produced by exposure to X-rays. The stability of these centres is studied by bleaching with temperature and light. The band having a peak at 5·6 eV is found to be composed of 2 bands having peaks at 5·6 and 5·87 eV. The band at 2·3 eV is studied as being due to electrons trapped by a negative-ion vacancy or by an aggregate of negative-ion vancancies. The luminescent centre of fused quartz is suggested to be an interstitial Si atom. It is concluded that fused quartz has a fair degree of short-range order. A.

535.343.2

8058. Absorption spectra of crystalline chlorophyll derivatives. E. E. JACOBS AND A. S. HOLT. Letter in *J. Chem. Phys.*, **20**, 1326 (*Aug.*, 1952).

The red band (658 mμ in solution) of the absorption spectrum of a colloidal suspension of ethyl chlorophyllide crystals, made by diluting acetonic solutions with water, is shifted to the red to an extent depending on the size of the crystals, with a limit of 745 mμ. This is due to resonance interaction between identical chromophores arranged in regular array. The shift of the blue-violet band is more complex, because the two components correspond to dipole vibrations in two mutually perpendicular directions. C. TURNER

535.343.32–15

8059. Infrared spectra of solutions of iodine in mesitylene. N. S. HAM, A. L. G. REES AND A. WALSH. Letter in *J. Chem. Phys.*, **20**, 1336–7 (*Aug.*, 1952).

Evidence against complex formation between I_2 and pure mesitylene. D. H. WHIFFEN

535.343.4

8060. Absorption of ozone in the region of the Huggins bands. Influence of temperature. E. VIGROUX. *C.R. Acad. Sci.* [*Paris*] **234**, 2439–40 (*June* 16, 1952) *In French.*

Tabulates $k_{18°}$ and $k_t/k_{18°}$, where k = absorption coefficient, for a number of temperatures and wavelengths in the ranges $-92°$ to $+120°$C and 3130–3401 Å respectively. See also Abstr. 7133 (1950). G. F. LOTHIAN

535.343.4

8061. Absorption of ozone at 18° below 3130 Å. E. VIGROUX. *C.R. Acad. Sci.* [*Paris*] **234**, 2529–30 (*June* 23, 1952) *In French.*

Gives a list of absorption coefficients at wavelengths in the region of the Huggins bands (3125–2300 Å) using two absorption cells of different lengths. They agree very well with the values of Buisson and Fabry. C. TURNER

535.343.4

8062. Absorption of ozone in the spectral region below 3130 Å. Effect of temperature. E. VIGROUX. *C.R. Acad. Sci.* [*Paris*] **234**, 2592–4 (*June* 30, 1952) *In French.*

Mean values of the quantity, d_t/d_{18} (where d_t and d_{18} are the optical densities of the same absorbing layer of O_3 at temperatures, $t°$, and 18°C respectively) are tabulated for a series of selected wavelengths in the interval, 3112 – 2448 Å; and for temps. of $-30°$, $-44°$, $-59°$ $-75°$ and $-92°$C. The effect of temp. is less evident at the lowest wavelengths. D. R. BARBER

535.343.4

8063. Absorption of ozone in the visible spectrum. E. VIGROUX. *C.R. Acad. Sci.* [*Paris*] **235**, 149–50 (*July* 16, 1952) *In French.*

Decimal coeffs. at 18°C are tabulated for intervals of *c.* 10 Å over the wavelength range, 4069 Å–7392 Å, and positions of absorption max. and min. are indicated. D. R. BARBER

535.343.4–14

8064. Line-breadths of the microwave spectrum of oxygen. R. S. ANDERSON, W. V. SMITH AND W. GORDY. *Phys. Rev.*, **87**, 561–8 (*Aug.* 15, 1952).

Line-breadth parameters for O have been determined with a Zeeman modulation spectrograph for fifteen microwave transitions occurring in the 5 mm wavelength region. Measured values lie in the range 0·0319 to 0·0516 cm^{-1}/atm., with a population weighted mean of 0·0475 cm^{-1}/atm. Investigation of the variation of the line-breadth parameter as a function of K, the rotational angular momentum quantum number, reveals greater line-breadth for the most populated states. This leads to an interpretation of the self-broadening collision process as a mechanism involving not only the quadrupole-quadrupole and polarizability interactions predicted theoretically, but also a rotational resonance interaction. Measurements are also reported for the line-breadths of O transitions broadened by the perturbing molecules NH_3, N_2O, N and A. Collision diameters are then determined for these molecules, and the results are shown to compare favourably with results from kinetic theory and from NH_3-broadening experiments. Interpretations of these data also strengthen the rotational resonance interpretation. A line-breadth parameter is calculated for air. A.

535.343.4–14

8065. Line breadth of OCS as a function of rotational transition and temperature. C. M. JOHNSON AND D. M. SLAGER. Letter in *Phys. Rev.*, **87**, 677 (*Aug.* 15, 1952).

It is found that the line breadth parameter $\Delta\nu$ of OCS, found by microwave measurements, increases with the rotational quantum number, contrary to Misushima's theory [Abstr. 6850 (1951)], and is proportional to $T^{-\frac{1}{2}}$, while kinetic considerations predict $T^{\frac{1}{2}}$. Experiments were carried out at 27°C and at dry ice temperature. The apparatus used is described. A. J. TAYLOR

535.343.4–15

8066. Contribution to the measurement of the intensity of infra-red absorption lines of a gas. J. VINCENT-GEISSE. *C.R. Acad. Sci.* [*Paris*] **234**, 2435–7 (*June* 16, 1952) *In French.*

Gives the theory of a method for measuring the total intensity and line width, when the latter is less than the slit width used. This involves plotting a function of measured absorption against cell length; rotational lines of the fundamental CO band have been measured. G. F. LOTHIAN

535.343.4–32

8067. Forbidden transitions in diatomic molecules. II. The $^3\Sigma_u^+ \leftarrow {}^3\Sigma_g^-$ absorption bands of the oxygen molecule. G. HERZBERG. *Canad. J. Phys.*, **30**, 185–210 (*May*, 1952).

For Pt I, see Abstr. 6671 (1950). The forbidden $^3\Sigma_u^+ - {}^3\Sigma_g^-$ absorption bands of O_2 in the near u.v. have been obtained under high resolution with absorbing paths up to 800 m. A detailed fine structure analysis has been carried out. It confirms the identification of the band system as a $^3\Sigma_u^+ - {}^3\Sigma_g^-$ transition. Precise values of the rotational constants Bv and Dv as well as of the vibrational quanta $\Delta G_{v+\frac{1}{2}}$ in the upper state have been derived. Each of the "lines" of the Q branches observed under low dispersion is resolved into six components whose spacing yields the triplet splitting in the upper state. This splitting is more than twice as large as in the $^3\Sigma_g^-$ ground state and is of opposite sign. The splitting constants λ

and γ have been determined and their variation with the vibrational quantum number observed. In addition to the *Q*-form branches weak *O*- and *S*-form branches have been found in agreement with the prediction of Present (1935) which is based on the assumption that spin-orbit coupling is the main cause for the occurrence of this forbidden transition. However, the relative intensities of the different branches deviate strongly from Present's prediction. The dissociation limit obtained from the convergence limit of the bands (without extrapolation) is at $41\,219 \pm 40\,\text{cm.}^{-1}$ This value is higher by about $220\,\text{cm}^{-1}$ than the value of the dissociation energy of O_2 derived from the Schumann–Runge bands. It is possible that the limit of the Schumann–Runge bands, which is based on a short extrapolation, and therefore the value of the dissociation energy of O_2 has to be slightly revised. The electron configurations and dissociation products of the various electronic states of O_2 are briefly discussed. A.

535.343.4–32

8068. Band spectrum of carbon-disulphide. II. C. RAMASASTRY. *Proc. Nat. Inst. Sci. India*, **18**, 177–85 (*May–June*, 1952).

For Pt I, see Abstr. 1205 (1948). The near u.v. absorption bands of CS_2 in the region 3 800 Å to 2 900 Å have been photographed under various conditions of pressure and path length. Experimental evidence has been presented to indicate that there are two band systems present, the more intense of which is the short wavelength one in the region 3300 Å–2900 Å. Long progressions were observed in this region with an interval of $450\,\text{cm}^{-1}$ which is interpreted as representing the totally symmetrical valence vibration (ν_1') of the upper state. All the various possibilities for the geometrical configuration of the upper state were considered and attempts were made to fit in the observed regularities with the expected band spectrum appearances for the different upper states. Most probably the electronic transition is between the linear ground state and a slightly bent upper state. On the basis of the selection rules put forward by Mulliken (1941) for such a transition, the bending vibration ν_2' and the anti-symmetrical vibration ν_3' of the upper state could be assigned the frequencies of $226\,\text{cm}^{-1}$ and $1050\,\text{cm}^{-1}$ respectively. The accidental equality of $\nu_1' = 450$ and $2\nu_2' = 452$ has led to a considerable displacement of the $2\nu_2'$ level due to a kind of Fermi resonance. A value of $657\,\text{cm}^{-1}$ for the ν_1'' vibration of the lower state has been confirmed from the u.v. absorption spectrum. A.

535.343.4–32

8069. The absorption spectra of gallium and indium monofluorides. D. WELTI AND R. F. BARROW. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 629–39 (*Aug.*, 1952).

Gaseous GaF and InF are formed when the metals are heated with aluminium trifluoride, and sufficient pressures of the monofluorides for observation of their absorption spectra are obtained at about 1000°C for GaF and 1400°C for InF. The three u.v. band-systems, $^1\Pi$, $^3\Pi_1$, $^3\Pi_{0+} \leftarrow {}^1\Sigma^+$ expected by analogy with GaCl and InCl have been photographed on spectrographs of moderate dispersion, and vibrational analyses have been carried out. The $^1\Pi$ states converge rapidly to give rather sharp dissociation limits: the products are probably Ga or In ($^2P_{3/2}$), + F($^2P_{1/2}$). The bearing of the present results upon the interpretation of the electronic levels of TlF and on the dissociation energy of AlF is briefly considered. A.

535.345

8070. The absorption of radiation by inhomogeneously dispersed systems. R. N. JONES. Note in *J. Amer. Chem. Soc.*, **74**, 2681–3 (*May* 20, 1952).

Absorption intensity errors due to transparent spaces between dispersed particles are discussed quantitatively. D. H. WHIFFEN

535.345

8071. The measurement of reflection, transmission and absorption of test pieces of arbitrary form in the Ulbricht integrating sphere. C. P. TINGWALDT. *Optik*, **9**, 323–32 (*No.* 7, 1952) *In German.*

The test piece is placed at the centre of an integrating sphere. A disappearing filament pyrometer measures the brightness of the test piece and the sphere wall. By variations of this method, the reflection, transmission and absorption coefficients may be determined. Practical details are given and the results obtained with sample test objects quoted. R. W. FISH

535.345 : 535.371

8072. Application of the metal model to the absorption and fluorescence of some dyes. E. LAFFITTE. *C.R. Acad. Sci.* [*Paris*] **235**, 36–7 (*July* 7, 1952) *In French.*

535.345 : 537.311.33 : 537.312.62

8073. Electrical and optical properties of rutile single crystals. D. C. CRONEMEYER. *Phys. Rev.*, **87**, 876–86 (*Sept.* 1, 1952).

Clear, synthetic rutile (TiO_2) single crystals have been investigated by electrical and optical methods. It seems possible to correlate the high temperature conductivity ($E_G = 3{\cdot}05$ eV) with the threshold of optical absorption at low temperatures (3·03 eV) and with the maximum of the photoconductivity (3·03–3–06 eV). This evidence indicates an energy gap *c.* 3·05 eV for rutile as an insulator. Semiconducting rutile, prepared by H reduction at temperatures ≤ 800°c, shows a blue colour arising from an optical absorption maximum at *c.* $1{\cdot}7\,\mu$ (0·73 eV). Conductivity-temperature plots for slightly reduced specimens indicate an optical activation energy of 0·68 eV. A theoretical calculation for the ionization of the first electron from an O vacancy indicates 0·74 eV as the expected value, in good agreement with the experimental results. At room temperature the mobility of electrons in slightly reduced single crystals is *c.* $10^{-4}\,\text{m}^2/\text{V-sec}$. Strongly reduced rutile is opaque; a comparison of electron concentrations calculated from weight loss and Hall coefficient data shows that for samples in which the electron concentration is $10^{26}/m^3$, all contribute to conduction at room temperature. A.

535.345 : 539.133

8074. The light absorption of iodine chain molecules. F. CRAMER AND W. HERBST. Note in *Naturwissenschaften*, **39**, 256 (*No.* 11, 1952) *In German.*

Iodine molecules in starch and other organic compounds lie in a channel, at distances of 3·06 Å,

forming a "one-dimensional metal." Supposing that all 7 valency electrons form the electron gas, Kuhns' theory [*Z. Elektrochem.*, **53**, 165 (1949)] gives for a chain of 14 atoms an absorption maximum at $\lambda = 6116$ Å; the experimental value for iodine amylose is 6200 Å. X-ray experiments show that this chain length is probably only a lowest value and that the mean value lies higher. The theory is correct for short chains only. C. TURNER

535.345 : 548.5

The infra-red transmission limit in optical materials. *See Abstr.* 8551

535.345.6 : 535.41

8075. Monochromatic light filters. N. I. SPERANSKAYA AND G. N. RAUTIAN. *Zh. Tekh. Fiz.*, **22**, 620–4 (*No.* 4, 1952) *In Russian.*

Describes the properties of a series of interference filters coupled with coloured ones. No filter transmits outside a range of 75 Å and the half width is about 20 Å with a maximum transmission of the order of 30%. J. M. HOUGH

535.371

8076. Absorption and fluorescence of some organic compounds, pure and in solution. P. PESTEIL. *C.R. Acad. Sci.* [*Paris*] **234**, 2532–4 (*June* 23, 1952) *In French.*

Pure crystals of anthracene and stilbene, anthracene in solution in stilbene, dibenzyl and tolane and stilbene in solution in dibenzyl and tolane are studied. The solute molecules do not lie parallel to the solvent crystal molecules and the latter perturb the normal absorption and emission bands of the solute, causing a shift to higher frequencies of 500 cm^{-1}. G. F. J. GARLICK

535.371

8077. The luminescence of organic substances. E. J. BOWEN. *Nucleonics*, **10**, 14–18 (*July*, 1952).

A short account of the mechanism of fluorescence in organic crystals and solutions. L. R. SHEPHERD

535.371

8078. Temperature effects in organic fluors. S. H. LIEBSON. *Nucleonics*, **10**, 41–5 (*July*, 1952).

Information on the mechanism of energy transfer in organic phosphors is reviewed briefly. Experimental measurements on the variation of light output from organic crystals between room temperature and liquid nitrogen temperature are described and results given for naphthalene and naphthalene–anthracene mixtures. Two methods of measuring the decay times of the luminescence of organic crystals are outlined, the one employing γ-ray excitation and depending upon the reduction in pulse size by delay line clipping, the other employing ultraviolet excitation and involving measurement of the phase lag in the fluorescent radiation, the exciting radiation being modulated at 10 Mc/s. The resolving time was about 5×10^{-10} sec. The decay times of a number of organic phosphors and temperature variation of the decay time for anthracene and naphthalene are given. L. R. SHEPHERD

535.371

8079. Internal absorption of fluorescent light in large plastic scintillators. C. N. CHOU. Letter in *Phys. Rev.*, **87**, 376–7 (*July* 15, 1952).

Three per cent anthracene in polystyrene or phenylcyclohexane solution in cylindrical form (20 cm long × 3·5 cm dia.) showed little absorption of fluorescence excited by cosmic rays or soft X-rays, but considerable absorption occurred in similar sized samples of 2% *p*-terphenyl in polystyrene. Scintillators of this type are thus useful for cosmic-ray telescopes, triggering cloud chambers and locating weak radioactive sources. G. F. J. GARLICK

535.371

8080. Fluorescence of naphthalene crystallized at 20°C. P. PESTEIL. *C.R. Acad. Sci.* [*Paris*] **235**, 150–2 (*July* 16, 1952) *In French.*

535.371

8081. On plastic scintillation phosphors. R. M. KLOEPPER AND M. L. WIEDENBECK. Note in *Rev. Sci. Instrum.*, **23**, 446–7 (*Aug.*, 1952).

Details are given for the production of large ampoules of 5% *p*-terphenyl in polystyrene plastic by polymerization of liquid solutions. Numerical efficiencies of these phosphors for Co^{60} rays are 23 to 28% for a 4 cm length specimen. G. F. J. GARLICK

535.371

8082. The absolute quantum yields of the fluorescence of chlorophyll solutions. L. S. FORSTER AND R. LIVINGSTON. *J. Chem. Phys.*, **20**, 1315–19 (*Aug.*, 1952).

An integrating sphere was adapted to the measurement of the quantum yield of the fluorescence of solutions of pigments. The intensities of the fluorescence and of the absorbed light were determined separately with a thermopile. Chlorophylls *a* and *b* dissolved in various solvents have been studied with this apparatus over a range of concentrations, and the measured yields corrected for autoabsorption. The yield for chlorophyll *a* is 0·25 and is in general independent of solvent and excitation wavelength. The yield for chlorophyll *b* is 0·11 for ether solutions and 0·06 for methanol solutions. The absolute fluorescent yields of solutions of fluorescein, eosine, magdala red, and rubrene were also measured. These results are in reasonable agreement with the published values of the yields for the same compounds. A.

535.371.07

8083. Production of fluorescent screens with colloidal solutions of polycyclic hydrocarbons in water. F. LUDWIG AND P. LE NOAC'H. *C.R. Acad. Sci.* [*Paris*] **234**, 2441–3 (*June* 16, 1952) *In French.*

0·5 ml of a solution of 1·9 g anthracene in 100 ml alcohol is added to 4 ml of air-agitated water to form a colloidal solution. This is evaporated in petri dishes with glass slides at the bottom of each dish on which a very fine grain screen is formed. The thickness is $\sim 10\,\mu$ and the grain size $\sim 300\,m\mu$. Electrical deposition from the solution is also effective. G. F. J. GARLICK

535.372

8084. Fluorescent spectra of some organic solid solutions. F. R. LIPSETT AND A. J. DEKKER. *Canad. J. Phys.*, **30**, 165–73 (*May*, 1952).

A method to measure the spectral distribution of the luminescence of solids is described. Use is made of a spectrophotometer in combination with a photomultiplier tube. Spectra have been investigated and discussed for solid solutions of naphthacene and

1,2,5,6-dibenzanthracene in naphthalene and anthracene as functions of concentration. A.

535.375.5

8085. Self-recording of Raman spectrum. H. LUTHER, G. BERGMANN AND A. MÜHLFELD. Note in *Naturwissenschaften*, **39**, 255–6 (*No.* 11, 1952) *In German.*

An apparatus for recording Raman spectra is described, and curves obtained for CCl_4 and benzene using this apparatus are given. G. I. W. LLEWELYN

535.375.5 : 548.7

8086. Anomalies in the scattering spectrum of piezoelectric crystals. III. Lithium perchlorate hydrate. J.-P. MATHIEU AND L. COUTURE-MATHIEU. *J. Phys. Radium*, **13**, 271–4 (*May*, 1952) *In French.*

For Pt II, see Abstr. 6425 (1952). Using a monocrystal in various orientations, the positions, intensities and types of Raman lines in the frequency range 60–3574 cm^{-1} have been determined. Results are tabulated and discussed. G. I. W. LLEWELYN

535.375.55

8087. On the proportionality in the Raman scattering by binary mixtures. G. DUYCKAERTS AND G. MICHEL. *Bull. Soc. Roy. Sci. Liège*, **21**, 102–14 (*March*, 1952) *In French.*

The intensity of Raman rays from a pure liquid is proportional to the number of molecules and to the coefficient of diffusion. The influence of the presence of different molecules on this coefficient of diffusion has been examined by investigation of the Raman scattering of (1) binary mixtures of non-associated substances, e.g. (*a*) cyclohexane–CCl_4, (*b*) toluene–CCl_4, (*c*) cyclohexane–toluene, (*d*) benzene–cyclohexane, and (2) mixtures of substances which give rise to molecular associations, e.g. (*a*) ether–$CHCl_3$, (*b*) ethyl methyl ketone–$CHCl_3$, (*c*) acetic acid–dioxan, (*d*) *n*-propyl alcohol–*iso*-propyl alcohol–methyl alcohol, (*e*) *n*-propyl alcohol–*iso*-propyl alcohol–CCl_4. The results obtained are tabulated. G. I. W. LLEWELYN

535.376

8088. Gamma- and alpha-produced scintillations in caesium fluoride. W. VAN SCIVER AND R. HOFSTADTER. Letter in *Phys. Rev.*, **87**, 522 (*Aug.* 1, 1952).

Small anhydrous CsF crystals grown in hydrogen give scintillations of blue-u.v. spectral emission with 1/10 the pulse height for scintillations from anthracene (using Co^{60} γ-rays and C7140 A photomultiplier). The decay time is 5×10^{-9} sec and is the shortest so far known for inorganic materials. For α-particle excitation the decay time is 2×10^{-7} sec and the relative efficiency is lower than that for γ-rays. G. F. J. GARLICK

535.376

8089. The response of sodium iodide crystals to high energy protons. J. G. LIKELY AND W. FRANZEN. Letter in *Phys. Rev.*, **87**, 666 (*Aug.* 15, 1952).

Reinvestigation of the response to protons with careful attention to sources of error shows that for protons of up to 18 MeV energy the mean scintillation intensities are proportional to particle energy. Spread in pulse height at 18 MeV is about 2·3% after suitable corrections are applied. G. F. J. GARLICK

535.376

8090. Average energy of secondary electrons in anthracene due to gamma-irradiation. G. D. PRESTWICH, T. H. COLVIN AND G. J. HINE. *Phys. Rev.*, **87**, 1030–1 (*Sept.* 15, 1952).

The average energy of the electrons produced in anthracene scintillators by γ-rays in the energy range from 0·28 to 2·76 MeV is determined experimentally. The values obtained are in good agreement with theory. Above 1 MeV γ-ray energy, crystal size is shown to be of importance due to leakage of high energy electrons from the crystal surfaces. A.

535.377

8091. Thermoluminescence and changes of color centers in LiF. J. SHARMA. Letter in *Phys. Rev.*, **87**, 535 (*Aug.* 1, 1952).

Using powdered LiF excited by 10 kV cathode rays at 90°K the results of Pringsheim and Yuster [Abstr. 6376 (1950)] have been confirmed; at 138°K the 3400 Å absorption band disappears with the emission of blue thermal glow. The latter has peaks at 138°K and 143°K. A broad thermal glow peak also occurs at 673°K associated with a change in the colour centre absorption. G. F. J. GARLICK

535.39 : 539.23

8092. Reflection coefficient of a very thin film deposited upon a metal support. M. PERROT. *Cah. de Phys.*, *No.* 37, 1–10 (*May*, 1952) *In French.*

Optical characteristics are studied theoretically by graphical methods. This permits the calculation of the reflecting coefficient as a function of thickness and these are compared with the thickness colour scale of Newton. The method developed is discussed in relation to the determination of the thickness of thin films. The variation of the reflecting coefficient and its dependence on the optical constants of the support is discussed. S. TOLANSKY

535.415

8093. On the effect of dispersion and multiple reflection upon the interference color. H. KUBOTA AND T. OSE. *J. Phys. Soc. Japan*, **7**, 470–3 (*Sept.–Oct.*, 1952).

The interference colour of a thin film was calculated taking multiple reflection within the layer and/or dispersion of the layer into account. The result shows that the effect of the former changes the purity of colour without altering its hue, whereas the latter changes its hue and purity. A.

535.417

8094. The pin-hole camera interferometer. J. RIENITZ. *Optik*, **9**, 206–15 (*No.* 5, 1952) *In German.*

Using the angle mirror interferometer [Abstr. 4267 (1952)] for the examination of surfaces with extensive thickness differences, there is no simple connection between the interference pattern and the surface structure. This can be overcome by placing a pin-hole of the correct dimensions near the beam-splitting surface of the interferometer. This produces an interference pattern similar to Haidinger's fringes, although they are real and can be formed on a screen without the use of an auxiliary lens. The method is compared with the Tolansky method. R. W. FISH

535.42

8095. On the asymptotic evaluation of diffraction integrals with a special view to the theory of defocusing and optical contrast. H. BREMMER. *Physica*, **18**, 469–85 (*June–July*, 1952).

An expansion is given of the function $u(x, y, z)$ that satisfies the scalar wave equation in the half-space $z > 0$ and equals a given distribution $u_0(x, y)$ in the plane $z = 0$. If u_0 is zero beyond a closed contour L in $z = 0$, $u(x, y, z)$ splits into a so-called geometrical-optical part (which vanishes outside the cylinder passing through L and having generating lines parallel to the z-axis) and a diffraction part (determined by the values of u_0 near L). Each part can be expanded into terms depending on $u_0(x, y)$ itself and on its iterative two-dimensional Laplace operators $\Delta^n u_0 = (\delta^2/\delta x^2 + \delta^2/\delta y^2)^n \; u_0(x, y)$. The expansions are in general asymptotic for small wavelengths; however, their exact validity can be proved for functions u_0 that are polynomials inside the contour L. The terms of the diffraction part consist of contour integrals along L, the corresponding terms for the geometrical-optical part do not depend on any integration. The first few terms of the latter part are essential for defocusing effects and can be connected with the brightness-contrast existing in the plane $z = 0$. A.

535.42

8096. Instrumental diffraction. I. Introduction of the pupil-pattern relationships. G. LANSRAUX. *Rev. Opt. (Théor. Instrum.)* **31**, 321–33 (*July*, 1952) *In French.*

Derives the relationships from Fresnel's hypothesis. The concept of the optical instrument is generalized, while the local variations of the transmission of the instrument are introduced into the diffraction theory by means of the concept of "amplitude filters."

R. W. FISH

535.42

8097. The influence of apodization on the structure of images of extended objects. A. SAEZ. *C.R. Acad. Sci.* [*Paris*] **235**, 148–9 (*July* 16, 1952) *In French.*

The intensity of the diffraction rings in a point image may be reduced by apodization although the diameter of the central disk is increased slightly. These results are applied to Foucault line test charts of different contrasts and the resolving power determined as a function of the chart contrast and degree of apodization. At high contrasts there is always a loss of resolving power but there is a small gain at low contrasts, 14% at a contrast of 0·03. R. W. FISH

535.42 : 777

8098. The theory of the half-tone screen: a study in diffraction. V. G. W. HARRISON. *Photogr. J. B*, **92**, 74–91 (*May–June*, 1952).

The light intensity pattern recorded in a half-tone screen process is shown to be the diffraction pattern formed by the screen from the coherent light coming from the lens diaphragm. This theory allows the isophots to be calculated for various conditions used in practice and the calculations are found to agree with experiment. Recommendations for the use of the screen are given and explained theoretically. The gradation of all screen negatives obtained through cross-line screens is shown to be faulty and it is not possible to produce a perfect negative by any manipulation of screen distances, stop sizes, etc. Any substantial improvement in tone rendering can be expected to come through the use of contact screens.

R. W. FISH

535.43 : 548.7

8099. Influence of the actual structure of a single crystal of sodium chloride on the scattering of light. L. TAUREL. *C.R. Acad. Sci.* [*Paris*] **234**, 2443–5 (*June* 16, 1952) *In French.*

Two extreme cases of cracks in the crystal are examined: rectangular rods and thin plates. The scattering intensity is calculated for an incident beam at an angle α to OX in the plane XOY, with the scattered beam at right angles in the same plane, or at right angles along OZ. C. TURNER

535.51 : 621.397.2

8100. Surfaces with multiple planes of polarization. Application to television. P. TOULON. *C.R. Acad. Sci.* [*Paris*] **234**, 2591–2 (*Juné* 30, 1952) *In French.*

The direction of the plane of polarization in polaroid sheets is the same over the whole sheet. Brief details are given of a combination of polaroids which gives a polarizing device in which the direction of the polarization plane varies in a regular and continuous fashion along two mutually perpendicular directions. This has been used in colour television.

H. G. JERRARD

535.514.2

8101. Analysis of polarized light reflected from absorbing materials at normal incidence. J. WOODROW, B. W. MOTT AND H. R. HAINES. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 603–16 (*Aug.*, 1952).

Expressions are derived for the intensity of the analysed light reflected from absorbing crystals (*a*) under crossed polarizing units, and (*b*) with the analyser slightly rotated from the crossed position. Four intensity maxima per complete rotation of the specimen are obtained when the polarizers are crossed, but under certain circumstances, as the analyser is rotated from the crossed position, the number of maxima may be reduced to two. These relationships are illustrated by experimental curves on specimens of Sn, U, Bi and stibnite. A.

535.65

8102. A double prism for the production of two movable colour fields in a differently coloured surround. G. C. MÖNCH. *Optik*, **9**, 216–18 (*No.* 5, 1952) *In German.*

A double prism is formed from two right-angled prisms, each having a small silvered patch on the hypotenuse, these faces being brought together to form a cube. Two perpendicular beams of light, which may be of different intensities or colour, fall upon the cube to give a field containing two patches whose separation may be varied by relative movement of the prisms. Practical details of the arrangement are given. R. W. FISH

535.7 : 612.84

Physiological optics. *See Abstr.* 8610–11

535.822.9

8103. New trends in microscopy. J. Dolejší and K. Slonek. *Czechoslovak. J. Phys.*, **1**, 27–42 (*No.* 1, 1952).

A review of the contemporary state of microscope objectives with special regard to reflecting micro-objectives and new methods of microscopic image formation; i.e. the phase-contrast method in ordinary and polarized light and the interference method. A.

535.822.9 : 578.682

8104. Polarization phase microscopy for the analysis [leptonischen analysen] of living cells. H. H. Pfeiffer. *Naturwissenschaften*, **39**, 305–6 (*No.* 13, 1952) *In German.*

This microscope uses a polarizer at the condenser diaphragm, an analyser in the eyepiece and a mica phase-plate in the rear focal plane of the objective. Both the amplitude and the phase difference may then be varied independently to obtain maximum contrast from the specimen. R. W. FISH

HEAT 536

536.081.4 : 535.231.2

8105. Interpretation of black body energy density and proposal for a temperature scale. Y. Rocard. *C.R. Acad. Sci.* [*Paris*] **234**, 2427–8 (*June* 16, 1952) *In French.*

The energy density of black body radiation in ergs/cm^3 may be written $U = 3/2\, kT(\beta T)^3$ where k is Boltzmann's const. and $\beta = 3{\cdot}317$. It is hence shown that the vol. of radiation which has the mean energy of a molecule at temp. T (in deg. Kelvin) is that of a cube of side $1/3{\cdot}317\, T$, which is the wavelength of the photons giving the max. energy in black body radiation. Hence a temp. scale is proposed in which the no. of deg. measuring a given temp. is the inverse of the side (in cm) of a cube containing at that temp. black body radiation energy equal to the mean energy of a molecule at that temp. The accuracy is limited to 1 in 2000, but the scale would be useful in astrophysics where radiation and thermal energies are always being compared. W. C. MOSS

536.1

8106. Count Rumford's concept of heat. S. C. Brown. *Amer. J. Phys.*, **20**, 331–4 (*Sept.*, 1952).

Rumford developed his concept of heat by analogy with the acoustic waves emitted by a bell. He felt that temperature was a measure of the frequency of vibration of the emitting source; the higher the temperature, the higher the frequency. This led him also to the belief in the existence of frigorific rays as separate entities from calorific rays. A.

536.2

8107. Thermal conductivity of solids and fluids from studies of aggregate matter. H. S. Strickler. Letter in *J. Chem. Phys.*, **20**, 1333–4 (*Aug.*, 1952).

Eucken's equation has been modified to $k = k_f F_1[(3 - 2P)k_s - 2Pk_f]/[k_f(3 - P) + Pk_s] + F_2$ where F_1 and F_2 are coefficients added by the author, k_s the conductivity of the solid, k_f the conductivity of the fluid, and P the porosity. $k_s \gg 1000k_f$. Results are given for systems lead–hydrogen–air, steel–hydrogen–air, silicon carbide and various gases, magnesium oxide and air. E. H. DOCK

536.2.01

8108. On the convergence of numerical solutions of the heat-flow equation. F. B. Hildebrand. *J. Math. Phys.*, **31**, 35–41 (*April*, 1952).

This mathematical paper considers the convergence, as $M \to \infty$, of the solutions of

$$r(v_{\mu+1,\nu} - 2v_{\mu,\nu} + v_{\mu-1,\nu}) = v_{\mu,\nu+1} - v_{\mu,\nu} \qquad (\mu = 1, 2, \ldots, M-1, \nu = 1, 2, \ldots),$$

$$v_{0,\nu} = v_{M,\nu} = 0 \qquad (\nu = 1, 2, \ldots),$$

$$v_{\mu,0} = f(\mu/M) \qquad (\mu = 1, 2, \ldots, M-1)$$

to the solutions of

$$u_{xx}(x, t) = u_t(x, t) \qquad (0 < x < 1, t > 0),$$

$$u(0, t) = u(1, t) = 0 \qquad (t > 0),$$

$$u(x, 0) = f(x) \qquad (0 < x < 1),$$

and establishes strict convergence when $0 < r < \frac{1}{2}$ for any function $f(x)$ of a very general class. W. C. MOSS

536.2.083

8109. On the determination of thermal coefficients of solid thermal insulators. M. V. Kulakov. *Zh. Tekh. Fiz.*, **22**, 67–72 (*No.* 1, 1952) *In Russian.*

The temp. distribution $\theta(x, t)$ in two materials A and B (A extending from $x = -R$ to $+R$, and B from $-\infty$ to $-R$ and $+R$ to $+\infty$) when a known amount of heat Q is instantaneously liberated at $x = 0$, $t = 0$ is derived theoretically. It is found that after time t_{max}, the temp. at any point x reaches a maximum θ_{max}; $t_{max} = f(x, R, \alpha_A, \alpha_B)$ where α is the thermometric conductivity, while $\theta_{max} = g(x, R, Q, \alpha_A, \alpha_B, \lambda_A, \lambda_B)$, the functions f and g being known from the theoretical treatment, and λ being the thermal conductivity. If the thermal constants of material B are known, and the heat liberation Q is measured, it can be seen that measurement of t_{max} and θ_{max} enables the unknown coeffs. α_A and λ_A of the experimental material to be deduced. An experimental method based on this theory is outlined; the material B is a standard, which can be used repeatedly, and as thermocouples need be inserted only in this material, samples of the experimental material A require little preparation. It is claimed that the technique is very rapid (6–10 min per experiment) and that it is suitable for routine measurements by unskilled staff. A. SCHOFIELD

536.21

8110. Heat flow in an infinite medium heated by a sphere. H. Goldenberg and C. J. Tranter. *Brit. J. Appl. Phys.*, **3**, 296–8 (*Sept.*, 1952).

A solution is given of the heat conduction problem in which a sphere generating heat at a constant rate is embedded in an infinite medium of different thermal properties. The solution is of use in a consideration of the disinfestation and sterilization of biological materials by differential heating due to the application of h.f. fields. Typical curves are given showing the transient temperature at the centre of the sphere for various ratios of the physical constants involved. A.

536.21 : 537.311.31 : 537.32

8111. On the thermal and electrical conductivities, and the thermo-electric force, of Sb/Zn alloys, with special reference to the influence of small admixtures of other metals. E. D. DEVYATKOVA, YU. P. MASLAKOVETS AND L. S. STILBANS. *Zh. Tekh. Fiz.*, **22**, 129–42 (*No.* 1, 1952) *In Russian.*

The authors refer to the previous studies of Sb–Zn alloys by Zhemchuzhnyĭ (1905) and Takei, which revealed the existence of metallic compounds SbZn, Sb_2Zn_3, and Sb_3Zn_4. When the proportion of Zn in the alloy is smaller than that corresponding to SbZn, the alloy can either be simply a mixture of different crystals or a eutectic, but when this proportion is larger, it is always a mixture of crystals. It has also been shown that Sb_2Zn_3 and Sb_3Zn_4 can crystallize into several forms (the "crystal phases," ε, ξ and η, for the former, and β and γ, for the latter) converting into each other at temperatures above 400°C. The present authors approach these metal compounds in the same way as usual in the case of semiconductors, such as PbS or PbSe, in which the relationship between the components is determined by their valencies. Smith (1911) found a sharp change of electrical conductivity, thermoelectric force and the Hall effect, when the proportions in the Sb/Zn alloy correspond to the SbZn metal compound. At the same time, they emphasize the fact that, contrary to the case of semiconductors, no change of sign of the Hall constant is observed in the metal alloys when the proportions correspond to the metal compounds, and the sharp changes at SbZn point are not observed at Sb_2Zn_3 and Sb_3Zn_4 points. The authors investigated the variations of the electrical and thermal conductivities and of the Hall constant of Sb/Zn alloys with the proportions in the neighbourhood of the metallic compounds, and also the influence of the admixtures of small quantities of Ag, Cd, In, Sn, and Te. They took special care to obtain pure alloys. From the data obtained for the Hall constant and for electric conductivities, they calculated in the usual way the electron concentrations and the concentrations of the "cavities". The influence of small admixtures of other metals to the alloy is characterized by the increase of the electrical and thermal conductivities while their proportions remain below a critical point, after which the conductivities begin to decrease. This is usually explained by the "filling of the cavities" in the alloy by the electron supplied by the admixed metal. The measurements, interpreted in terms of electron concentrations and the mobilities, generally confirmed this notion. It was found, however, that, contrary to the views expressed by Mott and Jones (1936) there is no connection between this influence of the admixtures and their valencies. In the opinion of the authors, this is due to the fact that while there is no limit to the increase of the concentration of ions, the upper limit of the reduction of this concentration cannot exceed 6×10^{18}. They attach considerable importance to the role which the admixtures can play by dissolving the impurities of the components of the alloy and improving the lattice that way. They illustrate this notion by the charts showing the relationships between the ion mobilities and their concentrations and the temperature in SbZn + Sn, obtained from the observations, and comparing them with the theoretical forecasts. In some cases the curves of cooling do not coincide with the curves of heating. The same kind of relationships occur with regard to the thermoelectric force. N. S. JAPOLSKY

536.212.3

8112. The thermal conductivity of certain powders at high temperatures. M. I. KOZAK. *Zh. Tekh. Fiz.*, **22**, 73–6 (*No.* 1, 1952) *In Russian.*

The thermal conductivity of quartz (silica-gel) and graphite powders over the temp. range 100–600°C was measured by Nusselt's steady-state concentric-sphere method. Three types of silica-gel, differing in grain size, were investigated: (*a*) mean grain dia. approx. 0·5 mm, (*b*) approx. 1·4 mm, (*c*) approx. 3–7 mm. From 100 to 300°C, the thermal conductivity of all three types was approx. equal (4×10^{-4} cal/sec/°c/cm). At higher temps. the conductivity increases with grain size; at 500°C the conductivities are:—Type (*a*) 7×10^{-4}, (*b*) 10×10^{-4}, (*c*) $12{\cdot}5\times10^{-4}$. This effect of grain size is attributed to the increasing importance of radiative heat transfer between grains at high temps. Two types of graphite were used—(*d*) Acheson 2301, containing 99% c (sp. wt. 0·69 g/ml) and (*e*) Korea, containing 85–87% c (sp. wt. 0·78 g/ml). The conductivity of type (*d*) varies betw. $6{\cdot}5\times10^{-4}$ at 100°C to $7{\cdot}2\times10^{-4}$ at 600°C; that of type (*e*) remains approx. const. ($=6\times10^{-4}$) up to 400°C, and thereafter increases to $6{\cdot}5\times10^{-4}$ at 530°C. A. SCHOFIELD

536.25 : 533.6.011.5

8113. Forced convection of heat at high velocities and high temperatures. E. BRUN AND M. PLAN. *J. Rech. Cent. Nat. Rech. Sci.*, **4**, 97–112 (*March*, 1952) *In French.*

A theoretical study is made of forced convection under the simplest conditions, then at high velocities and with large temp. gradients between solid and fluid. Experiments were made with a tubular element cooled at the ends, heated electrically in the middle to ~850°C and placed in a wind tunnel, the electrical input, the radiation and other heat losses being measured and the convection obtained by difference. Experimental results are correlated with a theoretical study of the influence of high velocities and of surface temp. on heat transfer. It was found that a rise in surface temp. made the laminar stationary layer less stable and facilitated a change to turbulence, and that a change from sub-sonic to supersonic velocities stabilized the layer and affected the convection considerably. The practical effect is that for supersonic velocities the flow can be streamlined over the whole surface of a projectile as long as the temp. is kept a little below that of normal friction, which can be done at high altitudes. W. C. MOSS

536.

8114. Temperature gradient owing to radiation absorption. G. B. SHOOK. Letter in *J. Appl. Phys.*, **23**, 931–2 (*Aug.*, 1952).

Experimental and mathematical studies have been made of the temperature distribution in a medium absorbing a time-dependent flux of radiation. The theory was tested by taking the surface temperature rise of a plastic material exposed to flashes from

photoflash bulbs. The agreement between theory and experiment, shown graphically, is close.

F. E. HOARE

536.413.2 : 538.221

8115. Thermal expansion of metallic gadolinium. F. Trombe and M. Foëx. *C.R. Acad. Sci.* [*Paris*] **235,** 42–4 (*July* 7, 1952) *In French.*

Reports measurements between −195° and 300°c. The coefficient of expansion is practically constant below the Curie point (16°c), but increases rapidly above, exhibiting some temperature hysteresis. This behaviour differs from that of iron, for which the coefficient passes through a maximum at the Curie point.

E. P. WOHLFARTH

536.413.2 : 538.221

8116. Thermal expansion of metallic dysprosium. F. Trombe and M. Foëx. *C.R. Acad. Sci.* [*Paris*] **235,** 163–5 (*July* 16, 1952) *In French.*

See also preceding abstract. Reports measurements between −195° and 300°c. The coefficient of expansion varies fairly rapidly with temperature below −90°c, at which temperature (which also corresponds to that of a maximum in the susceptibility curve) there is a sudden change of slope. Above −90°c the coefficient increases rapidly and reversibly with temperature.

E. P. WOHLFARTH

536.421.1 : 541.66

8117. Formula for the melting points of inorganic compounds of type MXO_n. S. Fujiwara. Letter in *J. Chem. Phys.*, **20,** 1338–9 (*Aug.*, 1952).

Discusses the author's empirical expression $T(\alpha_+ - \alpha_-)^{\frac{1}{3}} = a - b(r_-/r_+)$ where T is the absolute-scale melting point of the compound, while α and r represent the polarizability and ionic radius of the ion (cation or anion), respectively; the values a and b are claimed to be characteristic of a series of compounds having the same anion.

F. LACHMAN

536.423

8118. Distribution of density of mercury vapour over evaporating and condensing surfaces of liquid mercury. R. Ya. Barskaya, N. A. Denisyuk and L. A. Sena. *Zh. Tekh. Fiz.*, **21,** 1005–7 (*No.* 9, 1951) *In Russian.*

The article describes a practical test, with mercury, of the theory of V. L. Granovskii (abstract following) that the density of vapour, where there are two liquid surfaces of different temperatures, remains practically constant at a figure intermediate between those for the density of saturated vapour over the condensing and evaporating surfaces respectively. The process and results of measurement are illustrated by a diagram of the apparatus used and by a graph. The experiment is stated to have proved that density remained practically constant except in the areas, having dimensions of the order of the mean free path of the mercury molecules, immediately contiguous to the liquid surface of the mercury.

J. CLEUGH

536.423

8119. Data of evaporation of a liquid at different temperatures of evaporator and condenser. V. L. Granovskiĭ. *Zh. Tekh. Fiz.*, **21,** 1008–13 (*No.* 9, 1951) *In Russian.*

The problem is examined in the case of a vessel the sides of which are at a much lower temperature than the surface of the liquid. Regional conditions are calculated from the partial reflection of the molecules and the variation of the distribution of speed of the latter from the Maxwellian. The density, temperature and pressure of vapour are shown to remain practically constant throughout the volume of the vessel. Expressions are deduced which determine the above quantities, as well as the speed of evaporation of a liquid in the cases of either a plane or spherical configuration of the vessel employed. See also preceding abstract.

J. CLEUGH

536.423.4 : 533.7

8120. Point of condensation and the volume dependency of the cluster integrals. S. Katsura and H. Fujita. *Progr. Theor. Phys.*, **6,** 498–505 (*July–Aug.*, 1951).

In the theory of imperfect gas, the cluster integrals b_l depend on V (total volume of the system). The double limit process $V \to \infty$ and $l \to \infty$ defines two different functions $\chi(z)$ and $\chi\infty(z)$, [or, $\zeta(z)$ and $\zeta\infty(z)$]. The real behaviour of partition function is not given by $\chi(z)$, but by $\chi\infty(z)$, $\zeta\infty(z)$. Instead of the singularity of $\chi(z)$, the upper limit of the regular interval of $\chi\infty(z)$ is important. Inadequacy of the method of generating function is discussed.

A.

536.424

8121. Transition energy and volume change at three transitions in barium titanate. G. Shirane and A. Takeda. *J. Phys. Soc. Japan*, **7,** 1–4 (*Jan.–Feb.*, 1952).

The specific heat and thermal expansion of high purity $BaTiO_3$ ceramics have been measured at temperatures from − 120° to 150°c. This information allows calculation of the shifting rate of the transition temperature by hydrostatic pressure according to the Clapeyron–Clausius equation; the calculated values are in satisfactory agreement with the observations by Merz.

A.

536.424

8122. Phase transitions in solid solutions of $PbZrO_3$ and $PbTiO_3$. I. Small concentrations of $PbTiO_3$. G. Shirane and A. Takeda. *J. Phys. Soc. Japan*, **7,** 5–11 (*Jan.–Feb.*, 1952).

Dielectric, calorimetric and dilatometric measurements have been made on the solid solutions $Pb(Zr–Ti)O_3$ which contain small amounts of $PbTiO_3$ less than 10%. Besides the ordinary Curie point near 220°c, the existence of another transition, for example 140°c in $Pb(Zr95–Ti5)O_3$, was confirmed. It seems reasonable to interpret these two transitions as phase changes from a paraelectric state to a ferroelectric one and further to an antiferroelectric one. Whereas the upper transition temperature is nearly constant for these concentrations, the lower transition temperature increases with decreasing Ti concentration and both temperatures seem to coincide at pure $PbZrO_3$. These results suggest that $PbZrO_3$ may be antiferroelectric below its Curie point 220°c.

A.

536.424

8123. Phase transitions in solid solutions of $PbZrO_3$ and $PbTiO_3$. II. X-ray study. G. Shirane, K. Suzuki and A. Takeda. *J. Phys. Soc. Japan*, **7,** 12–18 (*Jan.–Feb.*, 1952).

The phase diagram of the whole range of the

$PbZrO_3$–$PbTiO_3$ system was determined by the dielectric and dilatometric measurements. According to the reason shown in Pt I, this phase diagram can be divided into three regions; paraelectric, ferroelectric and antiferroelectric phases. The crystal structure of this system was determined by Debye photographs. In the antiferroelectric region solid solutions have a tetragonal modification of perovskite structure with $c/a < 1$ and have some superstructure which seems to have an intimate relation to the antiferroelectricity. In the ferroelectric region, except a region near the antiferroelectric phase in which pseudo-cubic structure is observed, they have ordinary tetragonal structure of $c/a > 1$ without any superstructure. A.

536.424 : 548.736.3

8124. On the phase transition in cuprous iodide. S. Miyake, S. Hoshino and T. Takenaka. *J. Phys. Soc. Japan*, **7**, 19–24 (*Jan.–Feb.*, 1952).

The phase transition and the crystal structures of cuprous iodide (CuI) were studied by X-ray and calorimetric measurements. Two phase transitions at 369°C and 407°C were found and the corresponding energy and entropy changes were estimated from the specific-heat/temperature curve. The crystal lattice of the γ, β and α-phases were determined to be cubic (ZnS type), hexagonal (ZnO type) and cubic, respectively, by the X-ray powder method. The intensity change with temperature was measured in detail by a new method by which the Debye temperature factor can be taken into account more exactly. From this measurement, it was found that the crystal structure of this substance begins to change anomalously at about 200°C, and finally transforms into the high temperature form having an average structure; i.e. there are some metastable positions around every copper position of the low temperature form, and the probability of finding the Cu atoms in these positions gradually increases with temperature; finally, in the α-phase region, the atoms are equally distributed over all the positions. It was concluded that these probable positions are 4(*c*): (1/4 1/4 1/4) and 16(*e*): (xxx, $x\bar{x}\bar{x}$, $\bar{x}x\bar{x}$, $\bar{x}\bar{x}x$) of T_d^2 with the parameter $x \simeq 0{\cdot}34 \pm 0{\cdot}01$. The entropy change expected from this proposed structure change is fairly well in agreement with the value obtained by the calorimetric measurement. A.

536.424

8125. On diffusionless transformation in Au-Cd single crystals containing 47·5 atomic percent cadmium: characteristics of single-interface transformation. L.-C. Chang. *J. Appl. Phys.*, **23**, 725–7 (*July*, 1952).

A diffusion-controlled relaxation phenomenon was found with an activation energy of the order of 24 000 calories per mole. The two observed characteristics of diffusionless transformation of this alloy, that the transformation does not take place isothermally, and that the velocity of transformation on cooling is considerably and consistently larger than that on heating, can be successfully interpreted from the relaxation hypothesis. A.

536.44

8126. An additive method for the evaluation of critical temperature from the normal boiling-point. L. Riedel. *Chem.-Ing. Tech.*, **24**, 353–7 (*June*, 1952) *In German.*

Tabulates the following data for 191 organic compounds: b.pt., critical temperature (source given), ratio of these values, and the calculated ratio evaluated as the additive property of the compound. It is claimed that the values for atoms and groups, accepted by the author, give better results than those of Thomas [Abstr. 2403 (1950)]. The empirically found additivity of the magnitude $\sqrt{(M/p_c)}$ (M = molecular weight, p_c = critical pressure) is mentioned. F. LACHMANN

536.44

8127. The possibility of a theoretical calculation of the critical temperature. J. van Dranen. Letter in *J. Chem. Phys.*, **20**, 1175 (*July*, 1952).

It is assumed that at the critical point the average kinetic energy is equal to the average (negative) potential energy, U_c; thus $T_c = -2/3RU_c$. From the virial theorem and the results of Lorentz and Boltzmann expressions are obtained for the atomic radius in terms of the critical constants and used to compute values for the inert gases. The good agreement between calculated and observed values is not a sufficient proof of the fundamental assumption. F. E. HOARE

536.46

8128. Combustion of aluminium in air. R. de Salins. *C.R. Acad. Sci.* [*Paris*] **234**, 2437–9 (*June* 16, 1952) *In French.*

The spectrum (from 2300 to 10 000 Å) of Al powder burning in air (*a*) in a stationary flame (*b*) when dispersed by a small explosive charge, was investigated. Superposed on a continuum extending from 2500 Å into the near infra-red were found Al_2O_3 bands and certain Al lines: although the line-spectrum is more intense and complex in case (*b*), there is little difference in the intensity of the continuum. The spectral distribution in the continuum corresponds in both cases to a black-body temp. of 2900°C; it is suggested that the continuum is emitted by fine condensation droplets of Al_2O_3. Examination of the steady flame by means of a photomultiplier tube indicates that combustion is not continuous but takes place in a series of minor explosions, each lasting about 10 millisec; this is the duration of the flash from dispersed Al burning under conditions (*b*). A. SCHOFIELD

536.46 : 536.521

8129. A two-path method for eliminating the effects of self-absorption on temperature for isothermal flames. S. S. Penner. Letter in *J. Chem. Phys.*, **20**, 1341–2 (*Aug.*, 1952).

An outline is given of the theoretical basis of a proposed method of measuring flame temperatures by comparing the total line intensity observed when the flame is viewed against a cool black body as background with that obtained against a cool mirror as background. The method is applicable only to isothermal emitters and is experimentally simple; for spectral lines with Doppler broadening, the analysis of the results is also simple, but it is pointed out that if both Doppler and collision-broadening occur, the method, although still experimentally simple, involves more complicated analysis. A. SCHOFIELD

536.461

8130. Experimental evidence for anomalous population temperatures of OH in flames. S. S. PENNER. Letter in *J. Chem. Phys.*, **20**, 1334–5 (*Aug.*, 1952).

A brief survey of 11 papers dealing with "anomalous" OH temperatures in flames at atmospheric pressure and at low pressures reveals that the experimental evidence is practically uninterpretable in a quantitative and convincing manner. This is particularly so in the case of flames at atmospheric pressure, as large temperature gradients exist in such flames, so invalidating the application of isothermal theories. It is concluded that there is no strong exptl. evidence in support of abnormal rotation or vibration of OH in the $^2\Sigma$ state in flames.

A. SCHOFIELD

536.468

8131. The ignition of wood by radiation. D. I. LAWSON AND D. L. SIMMS. *Brit. J. Appl. Phys.*, **3**, 288–92 (*Sept.*, 1952).

The minimum intensities of irradiation required to ignite wood, with and without the presence of a pilot flame, have been determined, and found to be approximately constant for nearly all species. Empirical expressions have been obtained which relate the time taken to ignite with the intensity of irradiation and the density of the wood for these two types of ignition.

A.

536.48

8132. Molecular theory of liquid helium. M. TODA. *Progr. Theor. Phys.*, **6**, 458–79 (*July–Aug.*, 1951).

In order to explain the well-known peculiar character of liquid He an assumption is proposed that as the temperature is raised from 0°K atoms are excited by thermal agitation to form "molecules" of about 8 atoms each. Bose statistics is then applied to the system of atoms and molecules. The thermodynamical properties, thermomechanical effect, the so-called second sound, viscosity, etc., are quantitatively discussed, giving microscopic interpretation of these phenomena on the line proposed phenomenologically by Tisza (1947).

A.

536.48

8133. On the liquid He^3 and its mixture with He^4. M. TODA AND A. ISIHARA. *Progr. Theor. Phys.*, **6**, 480–5 (*July–Aug.*, 1951).

Recent experiments have shown that the λ-point of liquid He is lowered by addition of the isotope He^3. This depression of the λ-point is discussed theoretically by thermodynamics as well as by statistical mechanics.

A.

536.48

8134. Quantum-statistical theory of liquid helium. T. MATSUBARA. *Progr. Theor. Phys.*, **6**, 714–30 (*Sept.–Oct.*, 1951).

The λ-transition in liquid He is investigated on the basis of quantum statistical mechanics. In the first place, the partition function for an assembly of Bose particles is formulated in such a way that the effect of Bose statistics appears as a strong attractive potential between particles and gives rise to molecular clustering of various sizes, so that the assembly can be considered as a system of molecules and atoms obeying Boltzmann statistics. This formulation is then applied to the ideal Bose gas and to the actual He liquid, and the following results are obtained: (*a*) an ideal Bose gas undergoes a phase transition similar in its formal property to the condensation of a classical imperfect gas; (*b*) by taking into account the interatomic potential, but neglecting all the quantum effects but the statistics, a jump in the specific heat curve is obtained at the transition temperature and a value of the transition temperature coming nearer to the actuality; (*c*) beside the molecular clustering, or the "Bose-excitation," the quantum effects bring in the "Debye phonons" and the "Landau rotons," the former corresponding to the translational motions of the molecules and the atoms, and the latter to the rotational motions of the molecules. Although the quantum effects are not dealt with in detail, the agreement between theory and experiments is shown to be improved by taking them into account. It is also shown that these effects probably are not of very great importance even near the λ-point.

A.

536.48

8135. A new theory of liquid helium. H. N. V. TEMPERLEY. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 619–28 (*Aug.*, 1952).

A model of liquid He is described, which incorporates the main features of the Landau (1941) and London (1939) theories, making use also of Mayer's concept of clusters. The ordinary process of liquefaction is associated with the formation of clusters in co-ordinate space, while the λ-transition is probably associated with the formation of small clusters in momentum space. The latter process is probably prevented, or greatly modified, in He^3. Possible reasons for the appearance of superfluid effects are given, and it is suggested that the unique properties of He II may be traced to the fact that the interactions between two atoms is of about the strength needed to form a molecule.

A.

536.48

8136. Heat conduction in He II containing some ^{3}He. J. J. M. BEENAKKER, K. W. TACONIS, E. A. LYNTON, Z. DOKOUPIL AND G. VAN SOEST. *Physica*, **18**, 433–48 (*June–July*, 1952).

A directed heat current in a reservoir containing a He^3–He^4-mixture below the λ-point drives the He^3 towards that part of the reservoir which is artificially kept cold. The quasi-osmotic pressure due to this concentration gradient must in equilibrium be balanced by a fountain pressure caused by an appropriate temperature gradient. Thus a difference in He^3 concentration, X, across the reservoir gives rise to a difference in temperature, according to the equation $-RTp\Delta X = f\Delta T$. This temperature difference is equivalent to a resistance to the heat current, so that He II containing some He^3 does not have the virtually infinite heat conductivity of He II containing only He^4. The heat resistances have been measured as a function of the heat current for various concentrations of He^3. It was found to be proportional to the He^3-concentration. By combining the above equation with the diffusion equation $D(dX/dz) + v_nX = 0$ one can calculate from the heat resistance and the known He^3-concentration the diffusion constant D. This was found to be independent of He^3-concentration, and, at lower temperatures, in

good agreement with the values calculated by applying a gas model to the normal component of He II. The method of this experiment can be used to determine He^3-concentrations down to about 5×10^{-5} with a relative error of less than 5%. A.

536.48

8137. Entropy and specific heat of liquid He^3. K. S. SINGWI. Letter in *Phys. Rev.*, **87**, 540–1 (*Aug.* 1, 1952).

Considering liquid He^3 as a Fermi gas, the calculated entropy agrees fairly well with the entropy derived from the experimental vapour pressure curve [Abstr. 1805 (1951)] in the range from 1° to 2·5°K. However, below 1° the experimental entropy deviates and tends towards a value of 1·8 cal mol^{-1} $degree^{-1}$ at absolute zero. It is suggested that below 1°K He^3 may undergo a transition into a peculiar ordered state resembling a solid with a Debye temperature of 4·3°K. H. LONDON

536.48

8138. The effect of helium 3 ingredient on the wave propagation in liquid helium II. S. KOIDE AND T. USUI. *Progr. Theor. Phys.*, **6**, 506–23 (*July–Aug.*, 1951).

The effect of He^3 ingredient on the wave propagation in liquid He II is discussed phenomenologically on the basis of the two fluid model. The velocity of second sound numerically calculated is compared with experimental data. The comparison reveals the peculiarity of the normal and supercomponents essentially different from the He^3 component. A.

536.48

8139. Second sound in He^3–He^4 mixtures. P. J. PRICE. Letter in *Phys. Rev.*, **87**, 381 (*July* 15, 1952).

Assuming that the two fluid dynamics applies and that the He^3 atoms move with the normal fluid, expressions are given for the second sound velocity and for the density of the normal fluid. H. LONDON

536.483

8140. A helium liquefier of large output. L. WEIL. Letter in *J. Phys. Radium*, **13**, 241–2 (*April*, 1952) *In French.*

Short description of an all-metal, vacuum-insulated Joule–Thomson liquefier giving 2 litres of liquid He per hour. H. LONDON

536.483 : 535.33.07

8141. An optical cell for use with liquid helium. W. H. DUERIG AND I. L. MADOR. *Rev. Sci. Instrum.*, **23**, 421–4 (*Aug.*, 1952).

A low-temperature cell is described that permits spectral absorption and emission measurements, as well as high-energy irradiation of materials held at liquid He temperatures. The liquid He capacity of one litre is sufficient for up to 24 hr of continuous operation. Any substance whether it be solid, liquid, or gas at room temperatures can be studied. The all-metal cell is entirely portable and can be employed with a number of instruments without modification. A sylphon bellows arrangement permits vertical displacement within the cell of the samples under study. A.

536.532 : 533.6.011.6

8142. An investigation of the use of thermo-elements to measure the temperature of a high velocity gas stream. A. F. GANDELSMAN, N. V. ILYUKHIN AND L. N. NAURITS. *Zh. Tekh. Fiz.*, **22**, 268–76 (*No.* 2, 1952) *In Russian.*

Cu-constantan thermocouples, consisting of butt-jointed wires 0·1–0·5 mm dia. were fixed (*a*) axially, (*b*) transversely in a narrow tube through which air escaped from a high-pressure reservoir. The gas efflux could be varied by means of a valve at the tube exit. The recovery coeff. r (given by $(T'-T)/(\theta-T)$, where T' = measured temp., θ = stagnation temp. T = theoretical gas temp.) was measured over the range of Mach no. $M = 0{\cdot}2$ to 1·0; the value of θ was taken as the reservoir temp., while T was calculated from θ and measured gas pressures in the experimental tube section assuming adiabatic flow. For thermocouple wires parallel to the gas flow, the value of r remains const. = 0·90 for $M = 0{\cdot}24$ to 0·98, except near the inlet section of the tube, where r falls gradually from 1·00 to 0·90 over a length of approx. 4 × tube dia. For wires transverse to the gas flow, r depends both upon M and upon wire dia., increasing by about 10–20% as M increases from 0·3 to 1·0, and by up to 30% as the wire dia. is increased from 0·1 to 0·3 mm. Longitudinal wires are therefore to be preferred to transverse wires for measurement of gas stream temperatures. A. SCHOFIELD

536.63

8143. The surface contribution to the heat capacities of solids. J. T. LAW. Letter in *J. Chem. Phys.*, **20**, 1329–30 (*Aug.*, 1952).

Attention is drawn to the work of Tarrasov on heat capacities of one- and two-dimensional molecules and its application to graphite. It is suggested that if an equation of the Montroll type [Abstr. 4034 (1950)] can be fitted to the graphite results it should also be applicable to the heat capacities of adsorbed films. Montroll's limiting equation has been so applied and the parameter θ appears fairly constant. A brief summary of proposed experimental investigations on the heat capacities of adsorbed films is given. F. E. HOARE

536.631 : 536.48

8144. The specific heats of several metals between 1·8° and 4·2°K. I. ESTERMANN, S. A. FRIEDBERG AND J. E. GOLDMAN. *Phys. Rev.*, **87**, 582–8 (*Aug.* 15, 1952).

The specific heats of Mg, Ti, Zr and Cr have been measured between 1·8° and 4·2°K by the vacuum calorimeter method. In each case it has been possible to represent the results by an expression containing an electronic term linear in the temperature and a lattice term cubic in the temperature. The electronic contribution to the specific heats of these metals is in reasonable agreement with expectations based on the Sommerfeld theory and, in particular, with the results of more recent detailed calculations of energy bands in transition metals. This work has been facilitated by the development of a sensitive semiconducting resistance thermometer of Ge–In alloy for use at liquid He temperatures. A.

536.631 : 536.72

8145. Heat capacities of thin films and needles at low temperatures. I. M. LIFSHITS. *Zh. Eksper. Teor. Fiz.*, **22**, 471–4 (*No.* 4, 1952) *In Russian.*

Shows that flexural waves having a dispersion law

$w \propto k^2$, when propagated in thin films or needles, produce very characteristic heat-capacity/temperature relationships for the low-temperature range. The relationship for thin needles is $C \propto T^{\frac{1}{2}}$, while that for thin films is $C \propto T$. F. LACHMAN

536.631 : 536.72

8146. Thermal properties of the chain and laminar structures at low temperatures. I. M. LIFSHITS. *Zh. Eksper. Teor. Fiz.*, **22**, 475–86 (*No.* 4, 1952) *In Russian.*

Results obtained by the author for the case of thin films are taken into consideration in the derivation of the dispersion law for the long-wave portion of the spectrum of vibrations of a laminar crystal considered as a whole. In the law, the transverse rigidity of the individual atomic layers or chains is taken into account in addition to equations following from the theory of elasticity of a highly anisotropic body. Thermodynamic potentials derived from the law are used for the study of heat capacities, thermal expansion coefficients, and other thermodynamic magnitudes. The behaviour of the laminar, and chain, structures is similar to that of the thin films, and thin needles, respectively. F. LACHMAN

536.631 : 537.311.31 : 536.48

8147. Properties of metals at low temperatures. D. K. C. MACDONALD. *Progress in metal physics, vol.* 3, *pp.* 42–75 (1952). [See Abstr. 8617 (1952)].

A review. (i) Specific heats. A discussion of the classical theories is followed by a consideration of the various factors (internal transitions, lattice structure, electronic contributions) which may cause deviations from the classical formulae. The Raman theory is also discussed. (ii) Electrical conductivity. A theoretical and experimental discussion of the Bloch theory, particularly as applied to alkali and alkaline earth metals, is followed by a consideration of some later refinements in the theory ("Umklapp" process, electron-electron collisions). The low temperature resistance minimum which has been observed in many metals is discussed. Superconductivity, effects of specimen size, high-frequency resistance and magnetoresistance effects are briefly considered. 137 references. E. P. WOHLFARTH

THERMODYNAMICS 536.7/.8

536.7 : 530.145

Quantum mechanics and thermodynamic continuity. *See Abstr.* 7930

536.71 : 533.75

8148. On a new equation of state for gases. J. HIMPAN. *C.R. Acad. Sci.* [*Paris*] **234**, 2523–5 (*June* 23, 1952) *In French.*

The equation $[p + a/T^n v(v - b)](v - c) = RT$ where the constants are expressible in terms of the critical constants and the Boyle temperature closely reproduces the experimental results for H_2 and CO_2. See also Abstr. 3554–5 (1952). F. E. HOARE

536.71

8149. A simple proof of Van der Waal's equation. S. SENGUPTA. Letter in *Sci. Cult.*, **18**, 35–6 (*July*, 1952).

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.12

8150. On a model of the electron. J. M. THARRATS VIDAL. *J. Phys. Radium*, **13**, 283–8 (*May*, 1952) *In French.*

Based on de Broglie's theory of light. The electric density is a complex quantity. The charge within a region is obtained by means of a complex integration and it is then possible to obtain a finite energy for a point electron. L. PINCHERLE

537.12

8151. Dirac's new classical theory of electrons. B. HOFFMANN. *Phys. Rev.*, **87**, 703–5 (*Sept.* 1, 1952).

Similarities are pointed out between Dirac's theory and certain equations belonging to the projective theory of relativity. The latter include an electromagnetic potential of fixed gauge and are such that if one reduces them to special relativity in the conventional way by taking g_{ab} to be Galilean, one can extract from them equations closely corresponding to those of Dirac's theory. However, it is shown that taking g_{ab} to be Galilean ignores quantities that may not be negligible relative to Dirac's gauge-fixing constant $k^2 = m^2/e^2$; thus, effects arising from non-Galilean g_{ab} may be important in a theory of the type proposed by Dirac. When g_{ab} is not Galilean one apparently loses the central characteristic of Dirac's theory that all electric currents have m/e of electronic value. Equations of motion are still present, however. And since the gauge-fixed electromagnetic potential can be zero without contradicting the field equations, one need not postulate an ether for the reasons that arise from Dirac's theory. A.

ELECTROSTATICS . DIELECTRICS 537.2

537.213

8152. The measurement of the Volta effect. R. BOURION. *Ann. Phys.* [*Paris*] **7**, 360–95 (*May–June*, 1952) *In French.*

General problems in the measurement of the contact potentials between metals are considered. The experiments for the system Cu/W are described in detail. The Cu layers were deposited on aged W wires at a pressure of less than 10^{-9} mm Hg. The electrical system was so arranged that the electron beam from cathode to anode was completely screened from external influence. Anomalous behaviour was still observed, the characteristic curves being so dispersed as to give various values for the Cu/W contact potential. Heating the W wire to 700–800°c reduced the electronic work function by 0·15 eV. The anomalous results are explained on the basis of the mosaic structure of the W surface and the difficulty in obtaining a uniform Cu layer. Normally the Cu tends to aggregate at regions of high work function. C. A. HOGARTH

537.221 : 621.319.35

8153. Practical realization of an electric generator for nuclear research, giving a very high voltage by means of a dust current. M. MORAND, A. RASKIN AND L. WINAND. *C.R. Acad. Sci.* [*Paris*] **234**, 2450 (*June* 16, 1952) *In French.*

An electrostatic generator, using an airborne current of charged dust particles instead of the conventional belt, introduces a number of practical problems which are discussed. Solutions for all of these have been found and are indicated. The most difficult problem was that of making suitable insulating tubes. If the insulating properties were too poor, loss of charge occurred, while if they were too good parasitic charges would be built up on them by stray dust particles. Paper tubes with bakelite supports proved entirely satisfactory. A generator giving 1 mA at over 1 MV has worked for over five years with complete reliability. J. H. FREMLIN

537.226

8154. Study of the physical mechanism of charge in solid dielectrics. H. BONIFAS. *Rev. Gén. Elect.*, **61**, 223–31 (*May*, 1952) *In French.*

Empirical equations are given for the polarization and relaxation of individual molecules in electric fields which differ from those usually derived from the Lorentz differential equation. In Pt II the polarization of a linear molecular chain lying parallel to the applied field is considered and in Pt III the case of a solid mass of dielectric is considered as an aggregate of molecular chains. G. F. J. GARLICK

537.226.2

8155. Effect of tensile stressing on the dielectric losses and polarization of crystallizing polymers. G. P. MIKHAĬLOV AND B. M. FAĬNSHTEĬN. *Zh. Tekh. Fiz.*, **22**, 759–64 (*No.* 5, 1952) *In Russian.*

The results of an investigation of the dielectric losses and the polarization in polymers crystallizing under tensile stresses show that the observed reduction of the losses was due to a diminution of the distribution parameter or to a widening of the range of relaxation times. The latter may be caused by increasing inhomogeneity of the structure of the polymer. This increase of the degree of inhomogeneity can apparently be brought about by the crystalline phase formed as a consequence of the tensile stressing of the polymer. B. F. KRAUS

537.226.2

8156. The dielectric constants of heterogeneous mixtures of isotropic and anisotropic solids. W. NIESEL. *Ann. Phys.* [*Lpz.*] **10**, 336–48 (*No.* 6–7, 1952) *In German.*

A general theory is developed assuming that the grains are approximately ellipsoidal in shape. The results are found to be in agreement with experiments on the dielectric constant of $BaTiO_3$. C. A. HOGARTH

537.226.2

8157. Wall energy of ferroelectric domains. W. KÄNZIG. Letter in *Phys. Rev.*, **87**, 385–7 (*July* 15, 1952).

Gives a tentative interpretation of the ferroelectric behaviour of small particles of KH_2PO_4 [Abstr. 4337 (1952)]. E. P. WOHLFARTH

537.226.2

8158. Dielectric properties of lead titanate monocrystals. I. N. BELYAEV AND A. L. KHODAKOV. Letter in *Zh. Eksper. Teor. Fiz.*, **22**, 376–8 (*No.* 3, 1952) *In Russian.*

Relationship of conductivity and temperature of $PbTiO_3$ monocrystals is same as in semiconductors. Energy of activation is 1·06 eV. High conductivity determines relation of losses and frequency. With increase of frequency tan δ falls and only at very high frequencies begins to rise. On heating, losses quickly increase. Although due to high conductivity of crystals it was not possible to investigate temperature relationship of permittivity at and above Curie point yet considerable increase of permittivity with temperature, slow change of permittivity with frequency, also temperature relationship of conductivity classify crystals of $PbTiO_3$ as ferro-electric. J. LUKASZEWICZ

537.226.2

8159. Dielectric investigations on ferrites. G. MÖLTGEN. *Z. angew. Phys.*, **4**, 216–24 (*No.* 6, 1952) *In German.*

Reports measurements of the dielectric constant, loss angle and conductivity of various mixed ferrites between 50 c/s and 20 Mc/s. The results indicate that the specimens are inhomogeneous with narrow air gaps separating the crystal grains. A theoretical analysis is given based on the properties of a condenser with two differing dielectric layers between the plates. E. P. WOHLFARTH

537.226.2

8160. Distribution of potential in barium metatitanate and other ceramic dielectrics. E. V. SINYAKOV AND B. K. CHERNYĬ. *Zh. Tekh. Fiz.*, **22**, 265–7 (*No.* 2, 1952) *In Russian.*

Investigation in TiO_2, (Ba–Sr)TiO_3 and $BaTiO_3$ shows the distribution of potential to be linear in a wide range of temperature and independent of time of application of electric field. J. LUKASZEWICZ

537.226.2 : 612.1

8161. A comparison of the dielectric behaviour of pure water and human blood at microwave frequencies. H. F. COOK. *Brit. J. Appl. Phys.*, **3**, 249–55 (*Aug.*, 1952).

Methods used to measure the complex dielectric constant of water and blood at frequencies from $1{\cdot}7\times10^9$ to $2{\cdot}4\times10^{10}$ c/s are described. The results obtained for water at temperatures between 0 and 60°C are given and analysed with relation to the Debye and the Cole–Cole dispersion equations. The possibility that the dispersion in water is characterized by a narrow spectrum of relaxation times is briefly discussed. The complex dielectric constant of whole human blood has been measured at temperatures between 15 and 35°c. The dispersion observed is attributed entirely to water relaxation. It is shown to fit the Debye dispersion equations if the effects of a frequency-independent ionic conductivity are allowed for. Comparison of the results for blood with those for water leads to approximate estimates of the erythrocyte intracellular ionic conductivity and haemoglobin hydration. A.

537.226.2 : 621.3.011.5 : 621.315.61

8162. The dielectric properties of ice and snow at 3·2 centimeters. W. A. CUMMING. *J. Appl. Phys.*, **23**, 768–72 (*July*, 1952).

A knowledge of the permittivity and loss tangent of snow and ice is essential in studying both radar echoes from snow-covered terrain and the attenuation of microwave energy through snowstorms. To provide this information, a programme was carried out at the National Research Council of Canada to measure the permittivity and loss tangent of ice and snow, and also to determine the reflection coefficients of snow-covered surfaces, at a wavelength of 3·2 cm. As a result of these investigations values have been obtained for the permittivity and loss tangent of snow of varying density, temperature and water content. Theoretical values of the reflection coefficients of snow-covered surfaces, calculated from these data, are compared with the values obtained from the direct measurement of reflections from natural snow surfaces. A.

537.226.2 : 621.3.017.143 : 621.315.612.4

8163. Polarization and dielectric losses in zirconates, stannates and some titanates of divalent metals. G. A. SMOLENSKIĬ. *Zh. Tekh. Fiz.*, **22**, 3–11 (*No.* 1, 1952) *In Russian.*

The permittivity, its temperature variation and tangent of loss angle were investigated in zirconates, stannates and some titanates of divalent metals. It was found that in zirconates and stannates with perovskite type structure permittivity increases with the radius of divalent cation; also the sign of temperature coefficient of permittivity changes. The decrease of permittivity of Ba zirconate, and stannates of Ba and Pb, on increase of temperature can be explained by treating the oscillations of central ions of these crystals as anharmonic. Solid solutions of titanates, zirconates and stannates of Sr and Ca at given concentrations of initial components have a permittivity which depends little on temperature.

J. LUKASZEWICZ

537.226.2 : 621.3.017.143 : 621.315.615

8164. Dielectric loss of dioctyl phthalate at ultra high frequencies. S. S. SRIVASTAVA. *J. Brit. Instn Radio Engrs*, **12**, 280–4 (*May*, 1952).

The dielectric loss in solutions of benzene and liquid paraffin has been measured over the range 10^5 to $2{\cdot}35\times10^{10}$ c/s. In benzene the system is characterized by a single relaxation time and the variation of tan δ with frequency conforms to the original Debye theory. In liquid paraffin, the system is characterized by a spectrum of relaxation times. The values of the dipole moment determined from these two sets of measurements agree within $2\frac{1}{2}\%$. A.

537.226.2 : 621.3.017.143 : 621.315.612.6

8165. Dielectric losses in alkaline aluminium-silicate glass. N. M. VEREBEĬCHIK, A. E. KAMENCHIK AND V. I. ODELEVSKIĬ. *Zh. Tekh. Fiz.*, **22**, 12–15 (*No.* 1, 1952) *In Russian.*

Dielectric losses were investigated in high-silica potassium–aluminium–silicate glass of the general molecular formula $K_2O\,.\,xAl_2O_3\,.\,(17-2x)SiO_2$. These losses are a complex function of composition and generally high for this type of glass, higher than in silicate, and especially borosilicate technical glass. Properties of glass depend to a large degree upon a small change in the ratio of alkali oxide and alumina.

J. LUKASZEWICZ

537.226.33 : 621.395.645 : 621.319.5

8166. A mathematical analysis of a dielectric amplifier. L. A. PIPES. *J. Appl. Phys.*, **23**, 818–24 (*Aug.*, 1952).

The analysis is based on the assumption that the effective hysteresis curve of the amplifier's dielectric material may be represented by a hyperbolic sine function. The case of resistive load is analysed and expressions for the steady-state input and output currents are calculated. From a consideration of the transient response of the amplifier, an estimate of its time constant is obtained. A.

537.226.8 : 539.133

8167. The dielectric constant of some chlorine derivatives of ethane in the liquid and solid states. M. YASUMI AND M. SHIRAI. Letter in *J. Chem. Phys.*, **20**, 1325–6 (*Aug.*, 1952).

Diminutions of ε at lower temps. in crystals of 1, 2-dichlorethane and 1, 1, 2, 2-tetrachlorethane are attributed to reduction of the atomic polarization of the oscillations around the C–C bonds, which have frequencies of 33 and 23 cm^{-1} respectively at their melting points. D. H. WHIFFEN

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3

8168. A theory of contact noise. R. L. PETRITZ. Letter in *Phys. Rev.*, **87**, 535–6 (*Aug.* 1, 1952).

Based on the idea of temperature fluctuations in a "neighbourhood" of the contact, this region being such as to have its linear dimension larger than the mean free path for lattice scattering. The result leads to a $1/f$ law within ±3 db over nearly five decades of frequency. C. A. HOGARTH

537.3 : 621.38

8169. On the evaluation of noise samples. A. J. F. SIEGERT. *J. Appl. Phys.*, **23**, 737–42 (*July*, 1952).

Unless the primary source of noise is one of those which is theoretically tractable, the statistical properties of the noise have to be inferred from samples. Criteria have been developed to aid in the decision whether a sample can reasonably be assumed to have come from a Gaussian noise with predetermined parameters. A.

537.3.08

8170. An absolute ampere current balance for laboratory use. H. V. NEHER. *Amer. J. Phys.*, **20**, 358–62 (*Sept.*, 1952).

The instrument (used for teaching) is simple to construct; is absolute in that the current may be calculated from the dimensions and balancing weight only; is subject to a high degree of accuracy, especially for the larger currents; may be used for a.c. as well as d.c.; when current is passed through the movable conductor only, the balance may be used to measure the horizontal component of the earth's magnetic field. A.

537.311.31

8171. On the changes of electrical conductivity of metals at the time of melting. G. SUTRA. *C.R. Acad. Sci.* [*Paris*] **234**, 2589–91 (*June* 30, 1952) *In French.*

Normally the conductivities of solid and liquid metals σ_s and σ_l are not considered to be affected by the relatively small volume change on melting. The ratio σ_s/σ_l when calculated from melting point and heat of fusion using Fröhlich's theory is in satisfactory agreement for a few metals but disagrees for others. It is here shown that there is a smooth variation between $\Delta V/V$ and $\Delta\rho/\rho_m$ where $\Delta V/V$ is the fractional change in volume on melting, $\Delta\rho$ is the change in resistivity and ρ_m is the mean resistivity in the solid and liquid states. Thus there is a correlation between resistivity and change in volume for all metals with the exception of Hg. C. A. HOGARTH

537.311.31

8172. Resistance of metals at a high current density under impulse conditions. L. A. IGNATEVA AND S. G. KALASHNIKOV. *Zh. Eksper. Teor. Fiz.*, **22**, 385–99 (*No.* 4, 1952) *In Russian.*

At current densities $< 1\times10^6$ A/cm² the resistance of all metals investigated is fully determined by the energy supplied and independent of the current density. The value of the resistance is identical with that for weak currents at the corresponding temperature. High current densities under impulse conditions produce increased resistances in Pt and W which depend, for equal power supply, on the current density (or on rate of energy supply). Thus the resistance is no longer a monovalent function of the energy supplied. This does not apply to other metals. The relations observed are qualitatively similar to the deviations from Ohm's law predicted by electron theory, especially as occurring only at high current densities. They are not observed for Au, Ag and Cu, but only for metals of the transition group. Lorentz's theory predicts that the deviation occurs earlier where the mass of the charge carriers is larger. This applies to the effective electron mass of the transition metals. The theoretical prediction of the occurrence of the deviation at low temperatures was confirmed with Pt in liquid air. On the other hand, there are also considerable disagreements with theory, e.g. the strong increase of the resistance of Pt and W at a current density of 5×10^6 A/cm² whereas the theoretical value for even 1% resistance increase is one or two orders higher. The actual increase is also surprisingly rapid. More interesting details concern the position of the kink on the curves of resistance *v.* energy supplied. The position of these kinks coincides with phase transitions (fusing of conductors, etc.). B. F. KRAUS

537.311.31 : 536.48

8173. The electrical resistance of magnesium, aluminium, molybdenum, cobalt and tungsten at low temperatures. J. G. THOMAS AND E. MENDOZA. *Phil. Mag.*, **43**, 900–10 (*Aug.*, 1952).

Describes further results concerning the minimum of electrical resistance of metals at low temperatures [see also Abstr. 3531 (1951)]. Some Mg wires, known to contain 0·01 atomic per cent of Fe, exhibited definite minima; the magnetoresistance and the susceptibility were, however, independent of temperature. It therefore appears that though the minimum in zero field may well be an effect due to the presence of impurity atoms, the mechanism is not that of scattering of conduction electrons by unfilled electronic *d*-shells in these impurity atoms. Measurements on a dilute alloy of Mn in Al confirmed the filling of the *d*-shells of the transition metal by the multivalent solvent. The resistance of each of several samples of Mo went through a minimum rising to a constant value below about 0·1°K. A superconducting impurity ($T_c \sim 0{\cdot}4$°K; $H_0 \sim 30$ gauss), unidentified but probably a compound, could be produced by annealing. Samples of Co (hexagonal close-packed with traces of face-centred cubic) and W showed no anomalies or superconductivity down to the region of 0·06°K. A.

537.311.31 : 536.48 : 536.631

Properties of metals at low temperatures. *See Abstr.* 8147

537.311.31 : 537.32 : 536.21

The thermal and electrical conductivities, and the thermoelectric force, of Sb/Zn alloys, with special reference to the influence of small admixtures of other metals. *See Abstr.* 8111

537.311.31 : 539.11

8174. The resistivity of Cu_3Au during neutron irradiation. H. L. GLICK, F. C. BROOKS, W. F. WITZIG AND W. E. JOHNSON. *Phys. Rev.*, **87**, 1074–5 (*Sept.* 15, 1952).

Samples of initially ordered and disordered Cu_3Au have been irradiated in a nuclear reactor at 80°c. The fact that electrical resistivity measurements in the pile are continuous suggests that pile irradiation has both ordering and disordering tendencies. A.

537.311.31 : 539.23

8175. Transparent conducting films. E. J. GILLHAM AND J. S. PRESTON. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 649 (*Aug.*, 1952).

It is known to be difficult to produce on glass thin Au films which are uniform and of low resistance *R*. Cleaning the glass with dry precipitated chalk before depositing the Au reduces *R* considerably. On sputtered bismuth oxide (about 100 Å thick) Au films are produced which are uniform, of low *R*, and low absorption for white light. C. A. HOGARTH

537.311.32

8176. Contribution to the study of the conductivity of silicon. M. PERROT AND J. TORTOSA. *C.R. Acad. Sci.* [*Paris*] **235**, 143–5 (*July* 16, 1952) *In French.*

The resistance of thin films of Si (up to 0·3 μ thick) was measured under varying conditions of applied field and duration of application of the field. The resistance/applied field variation was interpreted as being due to a high capacity between the electrodes and the film and also between the grains of the film. For the thicker films (0·07 to 0·3 μ) the mean value of the resistivity was 5×10^6 ohm cm, which could be compared with the intrinsic resistivity at room temperature, $0{\cdot}25\times10^6$ ohm cm. C. A. HOGARTH

537.311.33

8177. On the adiabatic and isothermal Hall effects in semiconductors. L. S. STILBANS. *Zh. Tekh. Fiz.*, **22**, 77–9 (*No.* 1, 1952) *In Russian.*

An electric current can be represented, in the first approximation, as a stream of electrons moving with

velocities v, more or less near to their average velocity $\bar{v}$. A current directed along the x axis, in a magnetic field, H_z, will create in the direction y a potential gradient, vH_z/c, corresponding to the force tending to deflect the path of electrons and positive ions (the Hall effect) and further on it will cause a separation between the charged particles with $v > \bar{v}$ and $v < \bar{v}$, which will tend to concentrate on the opposite sides of the current and so create a corresponding temperature gradient. According to Gans two extreme cases can be distinguished in these phenomena: (1) the "adiabatic" Hall effect, where the thermal exchange can be neglected (the "Ettingshausen" effect), and (2) the "isothermal" Hall effect where the temperature can be assumed completely equalized by the thermal exchange. The author points out that hitherto in the prevailing majority of publications the Hall effect has been tacitly assumed to be isothermal, while in reality it is nearer to the adiabatic, unless special arrangements are made for the equalization of the temperature, such as placing the specimen in a bath, etc. This has also been stressed by Gottstein (1914). What has been so far entirely omitted, however, is the lattice thermal conductivity of the specimen itself. If this is taken into account, then, as the author shows, the formulae for the calculation of the Hall effect will have to be corrected, and, according to these corrected formulae, the real difference between these two cases will prove to be almost negligible. N. S. JAPOLSKY

537.311.33

8178. Change in the electric conduction of Sb_2S_3 and V_2O_5 on melting. V. A. YURKOV. *Zh. Eksper. Teor. Fiz.*, **22**, 223–9 (*No.* 2, 1952) *In Russian.*

Measurements of the conductivity, density and thermoelectric power of Sb_2S_3 and V_2O_5 at temperatures from room to over their m.pt., showed the abrupt increase in conductivity of Sb_2O_3 on melting to be reduced by admixture of free S (5% free S almost smoothed out the m.pt. step), apparently as a result of the effect of the S on the volume change of the semiconductor. Both Sb_2S_3 and V_2O_5 exhibited some parallelism between conduction and volume.

F. QUELON

537.311.33

8179. Kinetic processes in atomic semiconductors taking into account scattering of electrons by ions. A. I. ANSELM AND V. I. KLYACHKIN. *Zh. Eksper. Teor. Fiz.*, **22**, 297–302 (*No.* 3, 1952) *In Russian.*

The theory, taking account of the mechanism of scattering of current carriers on ionized centres, shows that the total resistivity is not the simple sum (as some authors had assumed it to be) of the lattice resistivity and that due to electron scattering. In the light of the amended theory, formulae are obtained for the thermo-e.m.f. and Hall constant. F. QUELON

537.311.33

8180. Electrical resistivity of SiC. W. SASAKI. Note in *J. Phys. Soc. Japan*, **7**, 107 (*Jan.–Feb.*, 1952).

Measurements of resistivity as a function of temperature in the range −190 to 100°C for three crystals are reported. C. A. HOGARTH

537.311.33

8181. On the semiconducting properties of molybdenite. F. REGNAULT, P. AIGRAIN, C. DUGAS AND B. JANCOVICI. *C.R. Acad. Sci.* [*Paris*] **235**, 31–2 (*July* 7, 1952) *In French.*

The conductivity and Hall constant were measured for MoS_2 specimens from hydrogen temperatures up to 300°C. It was assumed that p-type specimens contained some n-type centres and vice versa. All specimens examined had impurity concentrations of 10^{18}–10^{19} cm^{-3}. In an n-type specimen the electron activation energy was 0·14 eV and 5×10^{14} p-centres could be detected. It was not possible to estimate the concentration of n-centres in p-type specimens, even by measuring down to 20°K. Two hole activation energies 0·05 and 0·12 were measured for such a p-type specimen. Explanations for the observed behaviour are offered. C. A. HOGARTH

537.311.33

8182. Semiconducting properties of tellurium. P. AIGRAIN, C. DUGAS, J. LEGRAND DES CLOIZEAUX AND B. JANCOVICI. *C.R. Acad. Sci.* [*Paris*] **235**, 145–6 (*July* 16, 1952) *In French.*

Electrical conductivity and Hall effect measurements at temperatures from −193 to +50°C on single crystal (p-type) specimens of Te are reported. The intrinsic activation energy is found to be 0·34 eV and that for impurities about 0·039 eV, results agreeing with other recent work. The impurity concentration is of the order of 10^{15} centres/cm^3. Measurements at room temperature give for the mobility of the electrons 910 and of the holes 570 cm^2/volt/sec.

D. G. AVERY

537.311.33

8183. Statistics of the recombinations of holes and electrons. W. SHOCKLEY AND W. T. READ, JR. *Phys. Rev.*, **87**, 835–42 (*Sept.* 1, 1952).

The statistics of the recombination of holes and electrons in semiconductors is analysed on the basis of a model in which the recombination occurs through the mechanism of trapping. A trap is assumed to have an energy level in the energy gap so that its charge may have either of two values differing by one electronic charge. The dependence of lifetime of injected carriers upon initial conductivity and upon injected carrier density is discussed. A.

537.311.33

8184. Electron-hole recombination in germanium. R. N. HALL. Letter in *Phys. Rev.*, **87**, 387 (*July* 15, 1952).

The variation of lifetime τ with impurity content and with temperature T is calculated from the theory of recombination processes as applied to a p–n junction. Experiment confirms that over the range below intrinsic, τ is proportional to $1/T$.

C. A. HOGARTH

537.311.33

8185. A note on the theory of semiconductors. P. T. LANDSBERG. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 604–8 (*Aug.*, 1952).

One obtains two different theories of semiconductors, depending on whether the free energy due to

the spin of electrons in donor (or acceptor) centres is taken into account (approach A) or not (approach B). It is shown (i) that the former approach can be carried through for a degenerate semiconductor; (ii) that it applies formally to the case when the interaction between impurity centres and conduction electrons is taken into account, provided one of the symbols is reinterpreted; and (iii) that it is to be preferred. Approach B has, however, been used almost universally. It is shown that it corresponds to the unlikely situation in which 50% of the electrons from each impurity level come from paired states, and the remaining 50% from unpaired states having the same activation energy. A.

537.311.33

8186. Copper as an acceptor element in germanium. C. S. Fuller and J. D. Struthers. Letter in *Phys. Rev.*, **87**, 526–7 (*Aug.* 1, 1952).

Experiments using Cu^{64} are described and suggest that Cu may be a surface impurity which is responsible for the thermal conversion of *n*- to *p*-type Ge. The data for thermal acceptors and for diffused Cu are found to be identical. On annealing *p*-type Ge containing Cu for about 48 hours at 500°C, it reverts to *n*-type with a thin superficial layer of Cu. Similar experiments on Cu diffusion may be carried out on Si at 1100°C. C. A. HOGARTH

537.311.33

8187. Surface oxide films in intermetallic contacts. M. Cocks. Letter in *Nature* [*Lond.*] **170**, 203–4 (*Aug.* 2, 1952).

With the exception of gold and silver, it is shown that, in general, metals are covered with a thin oxide layer which increases markedly the resistance of metals in contact. These layers are not penetrated on normal loading, a lateral force being required, whereupon the contact resistance decreases and the frictional force increases. C. A. HOGARTH

537.311.33

8188. On the determination of the effective mass of the current carriers in semiconductors from their infrared absorption. K. B. Tolpygo. Letter in *Zh. Eksper. Teor. Fiz.*, **22**, 378–80 (*No.* 3, 1952) *In Russian.*

A relation between the effective mass M and the mean free path of the carriers and the absorption coefficient of a low frequency electromagnetic wave is derived. M may thus be found experimentally.

W. J. SWIATECKI

537.311.33

8189. Influence of the surface on the type of conductivity of a semiconductor. S. G. Kalashnikov and Ya. E. Pokrovskiĭ. *Zh. Tekh. Fiz.*, **22**, 883–4 (*No.* 5, 1952) *In Russian.*

The interruption of the lattice on the surface of a crystal gives rise to the local surface levels of the electrons (Tamm levels). These surface levels must have a special influence on the electric characteristics of a semiconductor, particularly if its structure is fine-grained. Very simple experiments (measurements of the thermo-e.m.f. at many points) are reported, showing clearly that the conductivity character actually varies in the surface layer. B. F. KRAUS

537.311.33 : 537.32 : 538.632

8190. On the electric properties of polycrystalline selenium. M. I. Iglitsyn. Letter in *Zh. Tekh. Fiz.*, **22**, 885–7 (*No.* 4, 1952) *In Russian.*

Chemically pure Se was crystallized under 60 to 80 kg/cm² and constant temperatures ranging from 117 to 218°C. Specific electric conductivity, differential thermo-electromotive force and Hall's constant were investigated between −180 and +200°C. It was found that the dissociation energy depends on the crystallization temperature. Within −180 and +200°C Hall's constant is practically independent of temperature, but electric conductivity increases exponentially with temperature. Measurements of thermo-electromotive force confirms that the concentration of carriers of current (holes) is independent of temperature, which is not in accordance with the zone theory of semiconductors. It is, however, in agreement with results obtained on monocrystals of Se. [Abstr. 6975 (1951)]. J. LUKASZEWICZ

537.311.33 : 537.32

8191. The problem of measuring the thermo-e.m.f. of semiconductors. B. Boltaks. Letter in *Zh. Tekh. Fiz.*, **22**, 892–3 (*No.* 5, 1952) *In Russian.*

Rejoinder to a note by Henisch [Abstr. 1814 (1952)] replying to previous criticism by the author [Abstr. 6231 (1951)] of Henisch's observations on a new effect, viz. the strong dependence of the thermo-e.m.f. on the value of the temperature difference of the junctions for the same values of the mean temperature of the specimen [*Elect. Commun.*, **25**, 2, 163 (1948)]. Repetition of Henisch's experiments by the author proved Henisch's observations to be due to experimental errors and not to characteristics of the substances investigated. Experiments without removing the established sources of error produced the "Henisch effect"; properly conducted experiments were free of it. B. F. KRAUS

537.311.33 : 621.3.011.22 : 621.315.59

8192. The properties of semi-conducting ceramic glaze. D. H. Lucas. *Brit. J. Appl. Phys.*, **3**, 293–6 (*Sept.*, 1952).

The surface resistivity and contact resistance of semiconducting glaze have been measured over the range of temperature −177 to 110°C. The rectifying effect with a metal point and the thermoelectric power indicate that the conduction process is electronic (*n*-type). The conductivity is thought to be mainly due to mixed crystals of $ZnCr_2O_4$–Fe_3O_4. The deterioration of glaze in service is due to electrolytic corrosion occurring at the interface with surface films of water. A.

537.311.33 : 621.314.7

8193. The physics of transistors. E. Billig. *Brit. J. Appl. Phys.*, **3**, 241–8 (*Aug.*, 1952).

Some of the fundamental concepts of the solid state which are required for an understanding of transistor action are discussed. The results of wave mechanics when applied to the solid state are outlined. The discrete levels of electron energy in single atoms and molecules become widened into energy bands in the solid. The large difference in the physical properties characteristic of such solids

as metals, insulators, intrinsic and extrinsic semiconductors, can be accounted for by the width and relative position of their energy bands. When two different solids are brought into contact electrical potential barriers arise which pass electrons more freely in one direction than in the other. If electrons and holes are present simultaneously in a semiconductor, interaction occurs between them and this can be used to produce transistor action, i.e. to effect control over the flow of relatively large currents in a solid by means of weak optical or electrical signals. A.

537.311.33

8194. Theory of the contact of a metal and a semiconductor with large contact difference of potential. A. I. GUBANOV. *Zh. Eksper. Teor. Fiz.*, **22**, 204–13 (*No.* 2, 1952) *In Russian.*

Current *v.* p.d. characteristics are calculated for plane, line and point contacts, where the contact p.d. is sufficiently large for a change from electron to hole conduction to occur in the semi-conductor near the contact. Both types of current carrier are considered in the theory, which indicates that the presence of hole conduction lowers the rectifying action of the contact. F. QUELON

537.311.33

8195. The magneto-effect in germanium point contacts. M. TOMURA AND Y. ABIKO. Note in *J. Phys. Soc. Japan*, **7**, 115–17 (*Jan.–Feb.*, 1952).

An explanation is offered for the incremental change in forward current when a magnetic field is applied across an *n*-type Ge diode, and is based on surface trapping of the injected holes. C. A. HOGARTH

537.311.33

8196. Area contacts on germanium. J. W. GRANVILLE AND H. K. HENISCH. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 650–1 (*Aug.*, 1952).

The rectifying properties of vacuum-evaporated metal (Au, Ag and Cu) area contacts on Ge are described. The saturation reverse currents are dependent on temperature as $i_s = i_0 \exp(-\phi/kT)$, where ϕ varies from 0·60 to 0·72 eV. The total current for small reverse voltages is directly proportional to the contact area. The peak back voltage and power vary with ambient temperature in a similar manner to those for point contacts on Ge and PbS. C. A. HOGARTH

537.311.33

8197. Contact properties of *p*-type germanium. J. W. GRANVILLE, H. K. HENISCH AND P. M. TIPPLE. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 651–2 (*Aug.*, 1952).

It is shown that thermally produced *p*-type Ge can act as an efficient crystal diode. The contacts between pairs of specimens of *p*-type Ge are analogous to those of Benzer (1949) for *n–n* contacts, and indicate the presence of a barrier of considerable height at these *p–p* contacts. C. A. HOGARTH

537.311.33

8198. Effect of minority carriers on the breakdown of point contact rectifiers. E. BILLIG. *Phys. Rev.*, **87**, 1060–1 (*Sept.* 15, 1952).

On the application of short high voltage pulses to point contact rectifiers in the inverse direction thermal instability is observed. Intrinsic conduction due to the thermal generation of electron-hole pairs and the subsequent passage of minority carriers (which are not affected by the potential barrier) is suggested as the cause of electrical breakdown. A.

537.311.33

8199. Electron multiplication in hard flows of selenium rectifiers. M. TOMURA AND Y. ABIKO. *J. Phys. Soc. Japan*, **7**, 524–7 (*Sept.–Oct.*, 1952).

Noises generated in a Se rectifier were measured at 600 kc/s for various reverse voltages and temperatures. They were analysed by the method of Haworth and Bozorth, and attributed to electron multiplication in the barrier layer owing to very high fields in the layer. Because the barrier layer is composed of selenide of about 10^{-5} cm thickness, the internal field will be as high as 10^6 V/cm at reverse voltages of the order of 10 V, thus creating impact ionization. The observed negative temperature coefficient of the avalanche noises will account for the abnormal temperature dependency of hard flows at high reverse voltages, since the latter may also be attributed to the electron multiplication. At higher temperatures and lower voltages, however, the noises seemed to be of the flicker type. A.

537.311.33

8200. Theory of the contact phenomena in semiconductors. A. I. GUBANOV. *Zh. Tekh. Fiz.*, **22**, 729–35 (*No.* 5, 1952) *In Russian.*

The paper represents a more exact delimitation of the fields of application of several variants of the theory of the contact of two semiconductors previously published by the author. A numerical example is calculated and comparison of the theory with experimental results is carried out for the contact of copper oxide with titanium dioxide. A qualitative interpretation of calculations of the author based on experiments with other pairs of semiconducting substances is also given. The last section of the paper analyses and discusses the various possible models of the mechanism of solid rectifiers [e.g. Abstr. 6960, 7853, 8732 (1951)]. B. F. KRAUS

537.311.35

8201. Electric conductivity of liquid dielectrics in strong fields. L. G. GINDIN AND YA. I. FRENKEL. *Zh. Tekh. Fiz.*, **21**, 986–93 (*No.* 8, 1951) *In Russian.*

Electric conductivity was investigated in solutions of iodine in isooctane and benzol, also in isooctane solutions of acetic acid, under electric stresses ranging from 300 to 40 000 V/cm. Solutions of iodine in isooctane and benzol have higher conductivities than initial hydrocarbons. Benzol solutions conduct better than isooctane solutions. These conductivities were found to rise exponentially with the electric stress, which shows that Frenkel's equation is valid not only for dielectrics with electron conductivity but also with ionic conductivity. J. LUKASZEWICZ

537.312.5

8202. The photoconduction of orpiment (As_2S_3) in strong electric fields. G. I. REKALOVA. *Zh. Tekh. Fiz.*, **21**, 1041–4 (*No.* 9, 1951) *In Russian.*

Subjected to fields of up to 2×10^6 V/cm, the illuminated and dark currents of 5–20 μ thick single crystals of As_2S_3 rose ohmically up to fields of the

order of 10^4 V/cm, thereafter very rapidly, almost exponentially, indicating commencement of ionization by collision. F. QUELON

537.312.5

8203. Some optical and photoelectric properties of orpiment (As_2S_3). G. I. REKALOVA. *Zh. Tekh. Fiz.*, **22,** 143–7 (*No.* 1, 1952) *In Russian.*

Measurements of the spectral distribution of absorption and photocurrent of single crystals of As_2S_3 at liquid air temperature, showed the photocurrent per unit of absorbed radiation to rise over a frequency interval extending 1200 Å in the short-wave direction from the long-wave edge of the band of strong absorption, reaching a maximum at about 1000 Å from this edge. In the zone of weak absorption (from 4300 Å), photoconductivity is proportional to absorbed energy and independent of wavelength.

F. QUELON

537.312.5

8204. Optical factors and the effective depth in the photoeffect of antimony-caesium cathodes. B. I. DYATLOVITSKAYA. *Zh. Tekh. Fiz.*, **22,** 84–100 (*No.* 1, 1952) *In Russian.*

The nature of motion of excited photoelectrons inside a Sb–Cs emitter is established by comparing the experimental values of photocurrent/thickness relationship with the calculated ones. The corresponding depth of emission of photoelectrons is determined at the same time. Some peculiarities of the photoeffect of Sb–Cs cathodes are discussed.

F. LACHMAN

537.312.5

8205. Measurement of photomultiplier fluctuations. F. LENOUVEL. *C.R. Acad. Sci.* [*Paris*] **234,** 2594–6 (*June* 30, 1952) *In French.*

537.312.5

8206. An effect of the anion on the conductive properties of triphenylmethane dye salts. R. C. NELSON. Letter in *J. Chem. Phys.*, **20,** 1327–8 (*Aug.*, 1952).

Chlorides of crystal violet and methyl violet have been found to show photoconductivity and large dark resistivities [Abstr. 6224 (1951)]. The normal sulphates and oxalates also show large photoconductivity but low dark resistivity when studied as thin continuous films on glass. It seems likely that in triphenylmethane dyes the conduction band is due to a mutual excited state of the dye cations, the sulphate or oxalate ion acting as a donor level. This view is supported by the lowered dark resistivity of a chloride film containing 5% oxalate. G. F. J. GARLICK

537.312.5

8207. On the photoelectric conductivity of zinc oxide. H. WEISS. *Z. Phys.*, **132,** 335–53 (*No.* 3, 1952) *In German.*

An investigation of the photoelectric conductivity of ZnO films as a function of the wavelength of the incident light and of the temperature. The films were 0·1 to 0·2 μ thick and deposited by evaporation in a high vacuum. The first part of the paper deals with room temperatures and the second part with temperatures of the order of 100°K. Relations have been established between the current i_0 in the absence of light, the total rise in current i_L due to illumination of strength B, the rate of rise in current when the illumination is switched on (r_1) and when it is switched off (r_2). They are $i_L \propto B^{1/3} i_0^a$, $r_1 \propto B i_0^b$, $-r_2 \propto i_L^2 i_0^{-2/3}$, where $a = \frac{2}{3}, \frac{1}{2}$, $b = 1$, 0·6 for 300°K, 100°K respectively. P. T. LANDSBERG

537.312.5

8208. Changes in the conductivity of thin ZnO films due to electron bombardment. G. HEILAND. *Z. Phys.*, **132,** 354–66 (*No.* 3, 1952) *In German.*

The conductivity of thin ZnO films is increased reversibly if they are bombarded by electrons of energy between 1 and 6×10^3 eV. The experiments described in this paper correspond therefore to those described in the preceding abstract, except that the photons are replaced by electrons. At room temperatures the laws which relate the parameters of the current-time curves are formally the same in both cases. P. T. LANDSBERG

537.312.5

8209. On the transport of energy in thin films of zinc oxide under bombardment by photons or electrons. G. HEILAND. *Z. Phys.*, **132,** 367–83 (*No.* 3, 1952) *In German.*

A theoretical interpretation is offered of the laws referred to in the preceding abstracts. This follows closely a theory due to Mollwo and Stöckmann [Abstr. 4980, 4982 (1950)] and is based on the application of reaction kinetics to a usual semiconductor model. It is suggested, as a result of these considerations, that the incident energy is absorbed mainly by the lattice rather than by the impurities (interstitial Zn^+ ions). The incident energy reaches the impurities by virtue of hole-diffusion. P. T. LANDSBERG

537.312.5

8210. Temperature relation of the spectral sensitivity of antimony-caesium photocells. V. S. KHAZANOV AND S. G. YUROV. *Zh. Tekh. Fiz.*, **22,** 744–6 (*No.* 5, 1952) *In Russian.*

The spectral sensitivity of Sb–Cs photocells was measured in the range 2537–7700 Å; in the ranges 2537–4000 Å and 7000–7700 Å only photoelements in uviol-glass vessels were measured. The spectral sensitivity was found to be well defined and strongly temperature-dependent. The curves of relative sensitivity *v.* wavelength at various temperatures form a family intersecting at a point above the abscissa ~ 5500 Å, where the sensitivity is therefore independent of temperature. In the red part of the spectrum (5500–7700 Å) the sensitivity increases with increasing temperature, in the blue part it falls. Calculations based on the spectral curves showed that the integral sensitivity of a Sb–Cs element irradiated with black radiation of $T = 2854$°K varies but insignificantly in the interval -20 to $+60$°C. The frequently held opinion of the temperature independence of the sensitivity of Sb–Cs cells is thus correct where the integral sensitivity is concerned.

B. F. KRAUS

537.312.5 : 537.53

8211. Investigation of the sensitivity of sulphur-silver photoelements to X-rays and their application for dosing with X-rays. I. M. POLYAK AND M. N. DYACHENKO. *Zh. Tekh. Fiz.*, **22,** 670–6 (*No.* 4, 1952) *In Russian.*

Three different S–Ag photoelements (no details of composition given) were found to possess high

ensitivity to X-rays, which does not change with ime. The current from the photoelements depends on the spectral composition of the X-rays and therefore when used for dosing with X-rays they must be differentially calibrated. For one of the photoelements, using a 1 mm Cu filter and a dose of 0·23 r/min, the photocurrent was $3\cdot73\times10^{-9}$ A, while with a 0·1 mm Cu filter and a dose of 24·45 r/min, the current was $2\cdot82\times10^{-7}$ A, so that in conjunction with a galvanometer of sensitivity 10^{-9} A per division it can be used as an X-ray dosimeter. Since the geometrical dimensions of the element are small enough, they can be used for determining the intensity distribution of X-rays in space. By using ZnS fluorescent screens the sensitivity can be increased enough for a galvanometer of sensitivity 10^{-8} A per division to be used. W. HUGHES

537.312.5 : 77.023

8212. Energy spectrum of the electrons in silver bromide crystals. B. BARSHCHEVSKIĬ. Letter in *Zh. Eksper. Teor. Fiz.*, **22**, 511–12 (*No.* 4, 1952) *In Russian.*

The photoelectrons required for the formation of the latent image are torn from the halide ions of the crystal lattice of the silver halide by light radiation of a wavelength inside the characteristic absorption band. If an electric field is applied to the crystal during the latent image formation, a photocurrent is set up, i.e. the photoelectrons, before being deposited at the centres of adhesion, are transferred to conductivity levels of the crystal. During the photoconductive process the electrons may reach the positive electrode or be captured, thus eventually forming centres or sub-centres of the latent image. Using experimental data on the spectral distribution of the internal photoeffect, the author presents a schematical diagram of the system of energy levels of the electrons in silver bromide crystals. B. F. KRAUS

537.312.62

8213. Superconductivity in the cobalt-silicon system. B. T. MATTHIAS. Letter in *Phys. Rev.*, **87**, 380 (*July* 15, 1952).

A Co–Si melt with 75% Si becomes superconductive at 1·33°K, but only about half the sample volume becomes free of magnetic flux. The melt is a mixture of Si and $CoSi_2$ crystals. Pure $CoSi_2$ does not become superconductive above 1·27°K. This and the observation that the transition temperature is lowered by annealing is ascribed to an increase of transition temperature by thermal stresses. H. LONDON

537.312.62

8214. A search for new superconducting compounds. B. T. MATTHIAS AND J. K. HULM. *Phys. Rev.*, **87**, 799–806 (*Sept.* 1, 1952).

In an effort to throw new light on the electronic and structural conditions necessary for superconducting behaviour, a magnetic test for superconductivity was applied to about 90 binary and ternary compounds at temperatures down to 1·28°K. The new superconductors Mo_2N, MoN, Mo_2B, NbB, $SrBi_3$ and $BaBi_3$ were discovered, and the superconductivity of TiN, ZrN, VN, Mo_2C, MoC and W_2C, reported by previous investigators using the inconclusive electrical resistance test, was confirmed magnetically. No trace of superconductivity was observed in any one of the several ionic, covalent, or semiconducting compounds examined or in 9 borides with Bo content greater than 50 atomic %. The results are discussed in relation to crystal structure and the periodic table. A.

537.312.62

8215. Measurements on the temperature, current, magnetic field phase diagram of superconductivity. K. MENDELSSOHN, C. SQUIRE AND T. S. TEASDALE. *Phys. Rev.*, **87**, 589–91 (*Aug.* 15, 1952).

Experiments have been carried out to investigate the existence of a paramagnetic effect, reported by other workers, at the transition to superconductivity. While, in the other experiments, the induction in the sample was measured during changes of the magnetic field, the work described in the present paper deals with induction measurements at constant values of magnetic field, current and temperature. The transition region of tin was investigated by separately varying, stepwise, each of these three parameters. With the current of 10 amperes used in the experiments, no paramagnetic effect was observed anywhere in the transition region. A.

537.312.62

8216. The phase transition in superconductors. I. Nucleation. T. E. FABER. *Proc. Roy. Soc. A*, **214**, 392–412 (*Sept.* 23, 1952).

A detailed study of "supercooling" in Sn rods has confirmed the hypothesis that this is caused by the difficulty of forming a nucleus of the superconducting phase. The experiments show that when nucleation does occur it only happens at certain flaws in the metal, which have been proved to lie at the surface and to be between 10^{-4} and 10^{-3} cm in size. These flaws do not appear to be necessarily associated with surface conditions, impurity content, or crystal boundaries. Any handling of the specimen affects them, but simply warming it to room temperature often does not, in which case the supercooling observed in separate experiments is reproducible. The degree of supercooling ϕ_l, defined as $(H_c^2 - H_l^2)/H_c^2$, where H_l is the field at which nucleation is first possible, varies in magnitude from flaw to flaw (0·8 is the largest value found), but it always depends on temperature in the same way, rising as $T \to T_c$. The supercooling can sometimes be increased by applying a high field to the specimen beforehand, indicating that some of the flaws can be temporarily destroyed by such treatment. The behaviour of the flaws can be accounted for if they are assumed to be domains where the interphase surface tension has become negative, perhaps as the result of local lattice distortion produced by dislocations. Using a simple model based on this picture the magnitude and temperature dependence of ϕ_l have been explained quantitatively in terms of the characteristic flaw size and the positive surface tension in the undistorted metal (as estimated from work on the intermediate state). Slight superheating (up to 1·5% of H_c) has also been observed. A.

537.312.62

8217. Electron-lattice interaction and superconductivity. K. S. SINGWI. *Phys. Rev.*, **87**, 1044–7 (*Sept.* 15, 1952).

An electron moving faster than sound would emit phonons in the form of a narrow wake behind it,

analogous to the Cherenkov radiation. Two electrons would, therefore, interact strongly when one lies in the wake of the other. Based on this idea a model for the superconducting state is suggested. The electron-lattice interaction, obtained by using the Bloch–Nordsieck transformation, is examined in the co-ordinate space, and the "wake" character of the interaction is shown. In the appendix, using a canonical transformation, the interaction between two electrons is calculated. A.

537.312.62 : 538.24

The magnetic properties of superconducting alloys of In and Tl. *See Abstr.* 8332

537.312.8

8218. On the theory of electric conduction of metals in a magnetic field. Yu. B. Rumer. *Zh. Eksper. Teor. Fiz.*, **22**, 214–22 (*No.* 2, 1952) *In Russian.*

A new mathematical approach to the general expressions for the resistivity of metals in transverse and longitudinal magnetic fields, taking into account the quantization of electron motion in the field, permits the derivation of formulae for the resistivities in the 2 important cases: (1) weak magnetic field, any temperature, (2) low temperature, any magnetic field. F. QUELON

537.321

8219. Thermoelectric phenomena in ferromagnetics near the Curie temperature. A. G. Samoĭlovich and L. L. Korenblit. *Zh. Eksper. Teor. Fiz.*, **22**, 360–6 (*No.* 3, 1952) *In Russian.*

Using Vonsovskii's $s-d$ "exchange" model, expressions are obtained for the Thomson and Peltier coeffs. which exhibit discontinuities at the Curie temperature—a change ($\sim 10^{-5}$ eV/°C) in magnitude of the former, and a change in temperature dependence of the latter. F. QUELON

537.362

8220. Evaluation of filtration processes in the presence of an electro-osmotic effect. A. V. Netushil and K. M. Polivanov. *Zh. Tekh. Fiz.*, **22**, 21–32 (*No.* 1, 1952) *In Russian.*

Discusses the problem of hydrodynamic fields in the presence of an electro-osmotic effect. Introduces the magnitude of the reduced potential (reduced piezometric pressure head) $\eta = h + k\phi$ (h = piezometric pressure head; ϕ = electric potential; k = coefficient characterizing the electro-osmotic properties of the filtering medium when a given liquid is filtered). Analyses the cases of the hydrodynamic field in only one, and in two filtering media, and discusses a numerical example. F. LACHMAN

ELECTRIC DISCHARGES 537.52

537.523 : 621.314.5

8221. On the theory of reverse current in ionic devices. B. G. Mendelev. *Zh. Tekh. Fiz.*, **21**, 1014–20 (*No.* 9, 1951) *In Russian.*

In cases of practical interest, the anode volume charge layer expands during the deionization stage more slowly than exponentially with time constant double the time constant of deionization, as had previously been assumed, and the reverse current peak is related to the rate of rise of reverse voltage. A formula is obtained giving approximately the latter relationship, and also formulae permitting separation from the measured reverse current of the anode displacement current component. F. QUELON

537.523.4

8222. Sparking potentials in a transverse magnetic field. J. M. Somerville. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 620–9 (*Aug.*, 1952).

A theory of sparking between parallel plates in a transverse magnetic field, put forward by Valle in 1950, is discussed and shown to be in qualitative disagreement with observation. By making allowance for the distribution of electron free paths, and for electron recapture by the cathode, a modified theory is produced which is in better agreement with observation. Further refinement of the theory requires an approximate expression for the first Townsend coefficient which is valid when a magnetic field is present. The possibility of obtaining such an expression is discussed. A.

537.523.4

8223. Electrical and spectroscopic measurements on low voltage sparks. J. van Calker and W. Maass. *Z. angew. Phys.*, **4**, 161–6 (*No.* 5, 1952) *In German.*

Describes expts. on a spark-arc circuit of the type used in spectroscopic analysis, after the work of Pfeilsticker. Circuit parameters are discussed in detail, and in relation to the intensities of the spectral lines 4525 Å (Fe I) and 4523·9 Å (Fe II). J. D. Craggs

537.523.4 : 778.5

[Physical] basis of spark cinematography. *See Abstr.* 8618–19

537.523.5

8224. On the processes of oxidation and transfer of metal of the metallic electrodes of a direct current arc. V. V. Borovkov and P. D. Korzh. *Zh. Tekh. Fiz.*, **22**, 227–37 (*No.* 2, 1952) *In Russian.*

Experiments with 5 A arcs of 6–12 mm dia., 2·3 mm apart cylindrical electrodes of steels of varying C content (in air), established the existence of 2 types of oxidation: (1) with preponderence of molecular diffusion of the reacting materials; (2) with preponderence of convective diffusion, which depended on the C content and surface temperature of the electrode, hence on its dimensions and on the current. Transfer of electrode material proceeded under oxidation mode (1), from cathode to anode, analagously to cathode dissipation in glow discharge; under mode (2), by spraying between the electrodes, independently of polarity. It is concluded that, by suitable choice of electrodes and arc parameters, it should be possible to prevent the loss of material from one of the electrodes. F. QUELON

537.523.74

8225. One-electrode high frequency discharge at pressures from a few millimeters of mercury to atmospheric at frequencies of 31·7 megacycles. G. S. Solntsev, M. Z. Khokhlov and E. A. Rodina. *Zh. Eksper. Teor. Fiz.*, **22**, 406–13 (*No.* 4, 1952) *In Russian.*

A continuous flow water calorimeter was used to measure the power developed as a function of pressure

for air, N and A atmospheres. The critical electrode potentials and the frequencies of secondary oscillations observed in the range 3–100 kc/s were measured. The place of the "torch" discharge in relation to other types of high-frequency discharges was established. W. J. SWIATECKI

537.525

8226. A determination of the vapour density in the positive column of an electrical discharge by Rozhdestvensky's "hook" method. A. M. SHUKHTIN. *Dokl. Akad. Nauk SSSR*, **82**, 41–3 (*No.* 1, 1952) *In Russian.*

An optical method, developed by Rozhdestvensky, for measuring vapour density by observation of the distortion of interference fringes near a spectral absorption line of the vapour, was applied to the vapours of Cs and Hg in an electrical discharge tube. For Cs at pressures between (approx.) 0·01 and 0·1 mm Hg it was found that the ratio of the vapour density in the positive column to the normal vapour density at these pressures ranges betw. approx. 1·10 when the current density is 0·1 A/cm² to 7·0 when the current density is 1·5 A/cm². Similar expts. on Hg vapour at a pressure of 0·76 mm Hg and current density 0·5 A/cm² indicated that the ratio under these conditions is 1·7, but this figure is regarded as less reliable than those for Cs. A. SCHOFIELD

537.525.4 : 537.56

8227. Ion concentrations and recombination in expanding low pressure sparks. R. G. FOWLER, W. R. ATKINSON AND L. W. MARKS. *Phys. Rev.*, **87**, 966–70 (*Sept.* 15, 1952).

Passage of a capacitor discharge through a low pressure gas between electrodes results in an abrupt expansion of the gas along any avenues open to it. In H, the expanding luminous gas shows strong Stark broadening. Applying this effect, ion concentrations have been measured ranging up to 30% of the initial particle concentration. Intensity measurements indicate that the quantized radiation is a result of electronic recombination. Time and space studies show that the ion concentration appears to reach a maximum at some remote position down the expansion avenue, but that all discharges reach a maximum at about the same time. A.

537.525.8

8228. Dynamic characteristics of the plasma in discharges through rare gases. H. N. OLSEN AND W. S. HUXFORD. *Phys. Rev.*, **87**, 922–30 (*Sept.* 15, 1952).

The time variation of ion concentration in the plasma of flash discharges through Ne and A at low pressures has been determined from the Stark broadening of H_α and H_β lines. H gas at about 1% of the total pressure was used for this purpose. A special method of oscilloscopic observation is employed. Analysis of the results explains differences in the time of appearance of various types of radiation in the discharge. A mechanism is proposed to account for the time variation of the intense continuum. A.

537.525.8

8229. The absorption of inert gases and fusion of the cathode surface during glow discharge. A. M. SHEMAEV, I. I. PAPENOVA AND I. S. ROĬZMAN. *Zh. Tekh. Fiz.*, **22**, 203–15 (*No.* 2, 1952) *In Russian.*

Experiments with electrodes of W, Mo, Ta, Ni, Cu, Al, Zn, Sn and graphite, at current densities up to 8 mA/cm², in up to initially 1·7 mm Hg of Ne, showed the inert gas to disappear during glow discharge as a result of absorption into metal melted by short duration micro-arcs on the cathode surface, and condensed on other electrode and glass surfaces. Heating the tube by external means released the absorbed gas completely from the lower m.pt. metals, but only slightly from those of higher m.pt. As graphite did not melt, it could be saturated with gas, so that at a certain current density further absorption ceased. F. QUELON

537.525.8

8230. Excitation of the ions in the low-pressure mercury discharge. YU. M. KAGAN AND V. M. ZAKHAROVA. *Zh. Eksper. Teor. Fiz.*, **22**, 400–5 (*No.* 4, 1952) *In Russian.*

The excitation of the ions and atoms of the mercury in the positive discharge column at low pressures is investigated. Spectroscopical investigations confirmed the Maxwellian character of the velocity distribution of the fast electrons. The excitation of the ions is a result of direct collisions of the atoms with electrons. Experiments with shift of the spectral lines indicate that the ions fall from the point of their generation practically free on to the walls of the discharge vessel. All these results agree very well with those of other workers in this field. The spectroscopical investigation adds some valuable details to the general conception of the phenomenon, particularly in the range of wavelengths investigated by the authors (3900–5500 Å). B. F. KRAUS

537.529

8231. Statistical time lag and electron avalanche in dielectric-breakdown of mica. H. KAWAMURA, M. ONUKI AND H. OKURA. *J. Phys. Soc. Japan*, **7**, 528–32 (*Sept.–Oct.*, 1952).

According to the "avalanche" theory of dielectric breakdown, the breakdown occurs by the energy dissipation of an electron avalanche composed of sufficient number of secondary electrons. Therefore, the breakdown probability is equal to the average frequency with which avalanches of such sufficient size occur. On the other hand, the breakdown probability can be obtained by the measurement of the statistical time lag of the breakdown. In this paper the statistical time lag of breakdown of mica and the pulse size distribution of avalanche noise in the pre-breakdown region were measured. Correlating both results from the viewpoint of avalanche mechanism, 10^8 was obtained as the avalanche size which is just sufficient to produce disruption for the specimens, which were $3 \sim 5 \times 10^{-4}$ cm in thickness. A.

537.529

8232. The pulse size distribution of the pre-breakdown noise. H. KAWAMURA AND M. ONUKI. Note in *J. Phys. Soc. Japan*, **7**, 121–2 (*Jan.–Feb.*, 1952).

The amplified voltage pulses appearing across a resistance in series with certain Indian micas, $1 \cdot 5$–$3 \cdot 0 \times 10^{-4}$ cm in thickness, were counted when the applied voltage approached the breakdown limit, pulses being selected of amplitude > some set value. The general conclusions derived are that the starting electrons of the avalanches are the conduction

electrons of the dielectrics, the avalanche current being $\sim 10^{-3}$–10^{-4} of the d.c. current at the breakdown field strength. The average avalanche size at the breakdown field value is $\sim 10^7$, as compared with the former figure [Abstr. 4379 (1951)] of 10^9.

A. J. KENNEDY

X-RAYS 537.531

537.531 : 535.343

8233. The M_V absorption edges of Tm and Er and the origin of the Er M_V absorption lines. P. A. Lee, E. A. Stewardson and J. E. Wilson. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 668–9 (*Aug.*, 1952).

The narrow absorption line of Tm in the M_V region is found to be a doublet, consisting of a transition line from M_V to 4*f*, and the M_V edge. The edge lies at 8469·5 ± 3X.U. giving a value for ν/R of 107·59 ± 0·07, in accordance with the computed value.

C. TURNER

537.531 : 535.345

8234. X-ray absorption coefficients of mica. G. B. Deodhar and C. Mande. *J. Sci. Industr. Res.*, **11B**, 265–8 (*July*, 1952).

The X-ray absorption coefficients of six principal forms of mica have been calculated. The absorption coefficient is lowest for muscovite and paragonite mica and highest for biotite mica.

A.

537.531 : 537.312.5

Investigation of the sensitivity of sulphur–silver photoelements to X-rays and their application for dosing with X-rays. *See Abstr.* 8211

537.531.08

8235. The problem of X-ray dosimetry with solids. I. Broser, H. Oeser and R. Warminsky. *Z. Naturforsch.*, **7a**, 351–60 (*May*, 1952) *In German.*

In contrast to photographic plates luminescence and conductivity in solids are simply related to the absorbed energy. However, in inorganic crystals the relation of the absorption, and therefore of these effects, to the wavelength of X-rays is complex and depends upon the effective atomic number. Organic hydrocarbon crystals show a behaviour more nearly related to that of ionization chambers and can be used for quantitative measurements. Qualitative detection is much easier, however, with inorganic crystals.

G. F. J. GARLICK

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533 : 621.384.612

8236. D.C. biasing of an electron synchrotron. E. G. Muirhead and B. M. Spicer. Note in *Rev. Sci. Instrum.*, **23**, 311 (*June*, 1952).

The use of d.c. bias substantially reduces the hysteresis loss in a synchrotron magnet. When first applied to the Melbourne synchrotron it was found very seriously to reduce the betatron injection efficiency. A coil on one pole only giving a few extra ampere-turns eliminated this loss up to 80° of back-biasing. Using this an X-ray yield of 20 r/min at 1 m was obtained for electrons at 14 MeV striking a 0·005 in Pt target.

J. H. FREMLIN (R)

537.533 : 621.384.613

8237. The 31-MeV betatron (ray transformer). R. Wideröe. *Brown Boveri Rev.*, **38**, 260–72 (*Sept.–Oct.*, 1951).

Gives a brief summary of betatron theory, and proceeds to describe a C-section betatron magnet and accessory equipment. Two electron guns were used in the vacuum chamber. Details of the spectral energy distribution and depth dose curves are given, with a histogram of the energy distribution of particles produced by disintegrations of carbon nuclei, with 31 MeV X-rays.

J. D. CRAGGS (R)

537.533.7

8238. Measurements of the fluctuations of the ionization losses for electrons in thin films of matter. V. S. Shpinel. *Zh. Eksper. Teor. Fiz.*, **22**, 421–4 (*No.* 4, 1952) *In Russian.*

Distribution curves of the ionization losses in Al of 1·65 and 3·96 mg/cm² thickness for electrons of energies 148 and 222 keV. The experimental values of the probable losses are in good agreement with theoretical ones, if the correction for lengthening of the path owing to scatter is considered. The resulting distribution is, however, considerably wider and flatter than corresponds to Landau's theoretical curve. It is asymmetrical, with the maximum shifted towards the side of growing losses.

B. F. KRAUS

537.533.7 : 621.384.62

8239. Axial motion of an electron in a constant wave velocity section of a linear accelerator. D. Caplan and E. Akeley. *J. Appl. Phys.*, **23**, 774–8 (*July*, 1952).

The relativistic differential equations for the axial motion of an electron in a wave guide, excited by a progressive, sinusoidal, longitudinal, electric wave of constant speed less than that of light in vacuum, have been integrated. The first integral yields the results of J. C. Slater (1948) and gives the energy–phase relationship, which is periodic. A second integration yields the phase distance relationship and thus completes the determination of the orbits. All separatrices are exactly integrable in terms of trigonometric and hyperbolic functions, while the general case requires elliptic integrals of the first and third kinds. The former are obtainable from tables, while the latter are evaluated by series expansions, or in the case of particles near the self-crossing point of the separatrices where the convergence of the series expansion is slow, by the use of the addition theorem for elliptic integrals of the third kind. These results are applied to the case of the proposed new Purdue Linear Accelerator. Energy distribution of the particles coming out of the end of the first two sections of this accelerator is in this way obtained.

A

537.533.7 : 621.384.62

8240. A multiple-cavity linear electron accelerator. B. L. Miller. *Rev. Sci. Instrum.*, **23**, 401–9 (*Aug.*, 1952).

A linear accelerator comprising 5 cylindrical cavities operating in the TM_{010} mode on the divided

power of a 10-cm magnetron (nominally 1 megawatt) has produced electron beams up to 1·4 MeV. The first cavity is a phase buncher; the remaining ones, accelerators. Power is fed to the cavities through series tee connections to a master waveguide which is loaded with dielectric rods for adjusting the relative phases. The fields are of the order of 100 kilovolts per cm. The maximum output has been 0·25 microampere average, 5% of the injected current. The accelerated electrons consist of a high energy bunch containing 50% of the total output current, with the remainder of the electrons spread over the lower energies. The energy of the bunched component can be varied widely by changing the magnetron voltage and by operating with fewer cavities. This accelerator has proven a reliable research tool in a study of secondary electron emission of solids as a function of primary electron voltage over the range of 18 kV to 1·4 MeV. A.

537.533.7 : 621.384.62

8241. 15 MeV linear accelerator. *Atomics* [*Lond.*] **3,** 199–200 (*Aug.*, 1952).

The machine (at Harwell) accelerates electrons on the travelling waves in a 20-ft corrugated Cu waveguide. A pressure of 10^{-9} atm. is maintained in the system. The u.h.f. power is supplied by a magnetron in 2 μsec pulses. The electrons bombard a metal target and the bremsstrahlung produce 2 μsec bursts of photoneutrons from Be. These are utilized in a 100-channel time of flight spectrometer.

L. R. SHEPHERD

537.533.72

8242. Reduced form of the fourth order eikonal and of the aberration coefficients in electron optics. O. I. SEMAN. *Dokl. Akad. Nauk SSSR,* **81,** 775–8 (*No.* 5, 1951) *In Russian.*

Expressions are given for the 8 Seidel coefficients of an axially symmetric magnetic + electric lens field, the paraxial equation being set up in the "reduced" form (Scherzer, 1936) in which $rV^{\frac{1}{4}}$ replaces r so that the term in r' is eliminated. This is found advantageous when solving numerically by the method of Motz and Klanfer [*Proc. Phys. Soc. Lond.*, **58,** 30–41 (*Jan.*, 1946); Abstr. 604 B (1946)]. J. C. E. JENNINGS

537.533.72

8243. The third-order aberrations of cylindrical electron lenses. N. I. SHTEPA. *Zh. Tekh. Fiz.*, **22,** 216–26 (*No.* 2, 1952) *In Russian.*

Mixed electrostatic + magnetic fields are considered, analogous to a cylindrical lens of light-optics: $\phi(y, z) = \phi(-y, z)$; $H_z(y, z) = H_z(-y, z)$; $H_y(y, z) = -H_y(-y, z)$. The variational function $\mu s'$ [μ = refractive index, s = path length] is expanded as a power series in y, y', x', the first approximation leading, via the Euler–Lagrange equations, to the Gaussian ray equations and the second approximation leading to differential equations for Δx and Δy, which may be solved by successive approximations. Expressions are given for the ten aberration coefficients in terms of integrals involving paraxial rays. Four of them are analogous to distortion, spherical aberration, curvature of field and tangential coma; the remainder depend on the initial value of x' [i.e. on "skewness"]. Four of these "skew" coefficients (viz. those associated with odd powers of x') are absent in the purely electrostatic case. J. C. E. JENNINGS

537.533.72

8244. On a method of approximation for the strongly curved trajectories of highly convergent lenses. F. BERTEIN. Letter in *J. Phys. Radium,* **13,** 309 (*May,* 1952) *In French.*

The polynomial representation of Abstr. 5832 (1952) is unsuitable in this case. A suitable approximate functional form is therefore obtained, the polynomial terms being retained to represent corrections to it. As an example, an electrostatic field which is an even function of z is considered.

J. C. E. JENNINGS

537.533.72

8245. The calculation of an electron lens for a given third-order aberration. P. P. KASYANKOV. *Zh. Tekh. Fiz.*, **22,** 80–3 (*No.* 1, 1952) *In Russian.*

A method is outlined whereby the axial potential of an electrostatic lens has been computed numerically, subject to given conditions of paraxial focusing and to the vanishing of primary coma, astigmatism or distortion, the coefficients of which are expressed as integrals involving the potential and its axial derivatives and 2 paraxial rays. Unsuccessful attempts have been made to find a potential distribution without infinities and giving zero curvature of field.

J. C. E. JENNINGS

537.533.72

8246. The aberrations of corpuscular beams of arbitrary form in an arbitrary electrostatic field. A. M. STRASHKEVICH AND I. M. PILAT. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **15,** 448–66 (*No.* 4, 1951) *In Russian.*

By ray methods expressions are obtained from which the second and third order transverse aberrations may be calculated in the following cases: (1) field having one plane of symmetry, whence the cylindrical lens is obtained as a special case (see abstract following); (2) cylindrical condenser; (3) the general case; (4) field having two planes of symmetry; (5) field having axial symmetry; in this case the formula reduces to that of Scherzer (1936).

J. C. E. JENNINGS

537.533.72

8247. On some aberrations of electrostatic systems having diad symmetry. I. M. PILAT, E. E. REZNIK AND A. M. STRASHKEVICH. *Zh. Tekh. Fiz.*, **21,** 1149–52 (*No.* 10, 1951) *In Russian.*

Formulae are given resulting from the application of theory described in the preceding abstract to these fields, and in particular to the perturbed unipotential lens. An integral expression is given for the spherical aberration so that conditions for its correction (Scherzer, 1947) may in principle be found.

J. C. E. JENNINGS

537.533.72

8248. Model for the motion of charged particles in magnetic fields with axial symmetry. D. L. KAMINSKIĬ AND V. M. KELMAN. *Zh. Tekh. Fiz.*, **22,** 703–8 (*No.* 4, 1952) *In Russian.*

The contours of the rubber model correspond to the equivalent potential, which includes the skew

constant. The magnetic lens formed by a single circular conductor has been investigated, with special reference to the problem of Tsukkerman [Abstr. 9519 (1951)]. It is shown that although rays, emitted ‖ to the axis from a source in the field, diverge from the axis on leaving the field, yet a family of paraxial rays from any given point near the axis is brought to a real focus, or at least has its divergence diminished. J. C. E. JENNINGS

537.533.72

8249. Model for the motion of charged particles in a two dimensional electric field, taking account of space charge. B. V. Bobykin, V. M. Kelman and D. L. Kaminskiĭ. *Zh. Tekh. Fiz.*, **22**, 736–43 (*No.* 5, 1952) *In Russian.*

If a membrane, stretched by a surface tension T, is subjected to a non-uniform pressure $P(x, y)$, the normal displacement z, if small, obeys $\partial^2 z/\partial x^2 + \partial^2 z/\partial y^2 = -P/T$, which is formally identical to Poisson's equation. Hence space charge can be represented as a distributed load. The distribution is found by successive approximations, the effects of space charge on the trajectories being initially neglected; the velocity distribution of the spheres, representing charged particles, then enables the first approximation to the space charge distribution to be calculated. An experimental model is described, in which the space charge loads are applied to a set of hexagonal pads on the under side of the rubber sheet. A test on an arrangement having a known analytical solution was satisfactory. J. C. E. JENNINGS

537.533.72

8250. On the question of the geometrical-optical intensity distribution in the image space of electron lenses. I–II. H. Grümm. *Optik*, **9**, 281–8 (*No.* 6); 289–311 (*No.* 7, 1952) *In German.*

For background see Glaser and Grümm, Abstr. 1098 (1951). Expressions for the surfaces of equal intensity (isophots) are developed in the sense of Seidels dioptics. The connection between this theory of the intensity distribution and the much more difficult wave mechanical theory is discussed. An appendix gives some possibilities for the measurement of caustic dimensions and their use in determinations of aberrations. A. H. W. BECK

537.533.72 : 621.385.833

8251. The focal properties and spherical aberration constants of aperture electron lenses. M. M. MacNaughton. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 590–6 (*Aug.*, 1952).

The focal properties and spherical aberration constants of a number of aperture electron lenses of varying diaphragm thickness and varying strength were determined numerically using potential distributions obtained (*a*) from a rigorous solution due to Ollendorff (1932), and (*b*) on a resistor network analogue. The focal lengths of "weak" aperture lenses of finite diaphragm thickness agree closely with those given by Davisson and Calbick's (1931, 2) formula for the "infinitely" thin aperture lens; "strong" aperture lenses of all thicknesses show systematic deviations from this formula. The primary spherical aberration constants of diverging aperture lenses are small, and of such sign that they cannot be used for the correction of the spherical aberration of converging electron lenses. A.

537.533.72 : 621.385.833

8252. Investigation of magnetic lenses having the axial field $H(0, z) = \gamma z/r^n$. U. F. Gianola. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 597–603 (*Aug.*, 1952).

Examination of the requirements for reducing the spherical aberration of an electron lens by modifying the field shows that the hypothetical lens field $H(0, z) = \gamma/z^n$ should have small aberrations. It is shown that the properties of a certain class of this general field configuration can be described in terms of an exact analysis. In particular, the electron optical properties of the γ/z^2 field are described in detail. The γ/z^2 field is found to have small aberrations, but practical conditions limit appreciable improvement in resolving power. The characteristics of the γ/z^3 field are also examined and are found to give little further advantage. A.

537.533.72 : 621.385.833

8253. An improved scanning electron microscope for opaque specimens. D. McMullan. *Instn. Elect. Engrs Paper* 1381, 12 *pp.* (1952).

A brief survey is given of the methods of examining opaque specimens in the electron microscope. The principle of the scanning electron microscope is described and mention is made of previous instruments. Their design is discussed and the theoretical limit on performance is determined. The optimum scanning-beam voltage, beam current and scanning speeds are given. A recently built electrostatically focused scanning electron microscope for opaque specimens is described. This has several new features: (*a*) The use of high-energy electrons to reduce the effects of surface contamination of the specimen. (*b*) Oblique scanning of the specimen, so that the image contrasts are formed by the topography of the etched surface of the specimen. (*c*) Direct amplification of the electron beam with an electron multiplier having BeO-coated dynodes. (*d*) Direct viewing at low magnifications on a c.r.t. with a long-persistence screen, and photographic recording from the screen at high magnifications. Examples of micrographs of Al taken with the instrument are included and these show a resolution of about 500 Å. It is concluded that higher resolutions could be obtained with this instrument if improved magnetic shielding and astigmatism correction were to be incorporated. Some measurements on the reflection of high-energy electrons are also described. A.

537.533.72 : 539.166.83

8254. A β-spectrometer with two magnetic lenses and with internal correcting coils. V. S. Shpinel. Letter in *Zh. Eksper. Teor. Fiz.*, **22**, 255–6 (*No.* 2, 1952) *In Russian.*

Source and receiver, 1 m apart, are at principal foci of respective lenses, which are iron-free coils 60 cm o/d and ~ 30 cm i/d. Coplanar with each coil is a correcting coil of 10 cm o/d. Dia. of source is 10 mm, of counter window 8 mm. With no current in correcting coils, ½-width of *F*-line of ThB was 3·2%; with appropriate correcting current, 2%, the gathering power being 1% of 4π. The *K* and *L* conversion lines from the 220-keV transition of the

90-hr isomeric state of Nb^{95*} were well resolved; the ratio of $K : L$ conversion coefficients was found to be $2{\cdot}5 \pm 0{\cdot}5$. J. C. E. JENNINGS

537.533.73

8255. Plural electron scattering and its influence on electron diffraction patterns. S. G. ELLIS. *Phys. Rev.*, **87**, 970–6 (*Sept.* 15, 1952).

The peak ring intensity (I'_R) and the background intensity (I'_B) for the most intense rings in the electron diffraction patterns of Al and TlCl have been measured, as a function of film thickness and accelerating voltage. It is shown that part of the discrepancy between the results and the theories of Bethe and Morse is due to plural electron scattering. A semi-empirical theory that includes the effect of plural scattering has been developed to explain the variation of I'_R and I'_B with specimen thickness. The contrast in the patterns (I'_R/I'_B) increases rapidly with accelerating voltage and falls rapidly with increase in film thickness. The maximum film thickness (T_{max}) that will yield an observable pattern increases less rapidly than the accelerating voltage, between 50 and 150 kV, in agreement with the results of Möllenstedt [Abstr. 8040 (1950)]. A.

537.533.73

8256. On an observed case of the diffraction of electrons from the molecules of a gas. A. I. ANDRIEVSKIĬ AND I. V. KUTOVYĬ. *Dokl. Akad. Nauk SSSR*, **82**, 225–8 (*No.* 2, 1952) *In Russian.*

Of the metal atoms leaving a cathode a considerable fraction condenses back on it. There is in fact a thin cloud of atoms close to the cathode which may enter into chemical combination with the surrounding atmosphere. Electrons from the cathode penetrating this cloud may show a diffraction pattern. This has been observed with Cu and Cd cathodes in air at pressures of 10^{-2}–10^{-3} cm Hg. The positions of the maxima agree with calculated patterns from Cu_2O and Cd_2O and CdO molecules. W. J. SWIATECKI

537.533.74

8257. The single elastic scattering of positrons by nitrogen nuclei. R. R. ROY AND L. GROVEN. *Phys. Rev.*, **87**, 619–21 (*Aug.* 15, 1952).

The nuclear scattering of positrons from Rh^{102} by N was investigated by the cloud chamber method. The number of photographs taken was about 5000, yielding 5212 positrons of energy lying between 0·53 MeV and 0·98 MeV with a total track length of 712 m. The number of cases of scattering observed was 85·0, whereas Massey's theory predicted 8·19. The ratio of the experimental results, which covered the angular range 15° to 85°, to the theory was 0·96. This agreement favours the assumption of Massey that the scattering of positrons takes place on the interaction of the Dirac particle of positive charge with the field of the nucleus. A.

537.533.74

8258. Scattering of electrons from point singularities in metals. D. L. DEXTER. *Phys. Rev.*, **87**, 768–77 (*Sept.* 1, 1952).

Mott's calculations on the scattering of electrons from substitutional impurity atoms are extended to include the scattering from interstitial atoms and vacancies; the effects of lattice distortions around the singularities are taken into account. It is found that the lattice distortions do not change the order of magnitude of the calculated resistivity in most cases of practical interest, but may in some cases make a difference of a factor of three or more for substitutional atoms of the same valence as the replaced atoms. It is concluded that the resistance change due to a dissociated vacancy-interstitial pair in a monovalent metal of atomic number Z is about equal to or somewhat larger than that due to two divalent substitutional atoms of atomic number $Z + 1$. Changes in the temperature-dependent part of the resistivity as a result of lattice distortions are found to be of the same order, at room temperature, as the changes in the residual resistivity due to the lattice distortions. A.

537.533.9

8259. The influence of multiple scattering on the angular width of Cerenkov radiation. K. G. DEDRICK. *Phys. Rev.*, **87**, 891–904 (*Sept.* 1, 1952).

One may measure the angle at which visible Cherenkov radiation appears from fast charged particles as they pass through a thin transparent plate. This angle is related to the velocity of the particle in a simple manner, and therefore offers a method of measuring the velocity. The angular width of the radiation is important in that it determines the resolution of the velocity measurement. This width contains contributions due to diffraction, energy loss of the charged particle, and multiple scattering. In this paper, the effects of multiple scattering and diffraction are considered in the following manner. The path of the particle through the transparent plate is considered to be a series of connected short straight-line segments. The radiation is calculated classically from this path, and with the aid of the results of multiple scattering theory, an ensemble average is taken over all possible paths. Two different methods are used in evaluating the radiation average. One is valid at viewing angles near the radiation maximum, and the other at viewing angles differing appreciably from the maximum. Curves are presented that give the radiation intensity as a function of the viewing angle for a variety of cases. A.

537.534

8260. Acceleration of beryllium and carbon ions in a synchrocyclotron. C. N. CHOU, W. F. FRY AND J. J. LORD. Letter in *Phys. Rev.*, **87**, 671 (*Aug.* 15, 1952).

Carbon ion energies of up to 1·1 BeV have been obtained. δ-Ray and scattering measurements in the nuclear emulsion detectors gave agreement with theory. J. J. WILKINS

537.534 : 621.3.013 : 621.384.62

8261. The numerical calculation of the electromagnetic field in linear ion accelerators. M. BERNARD. *C.R. Acad. Sci.* [*Paris*] **234**, 2175–8 (*May* 26, 1952) *In French.*

See Abstr. 1846, 2740 (1952). Approximate solutions, simple in form, are deduced from the complicated general expressions given in the earlier notes. A. H. W. BECK

537.534 : 621.384.62

8262. Note on the development of a 800 kV acceleration tube. P. C. Veenstra, H. M. Jongerius, C. H. Paris and F. P. G. Valckx. *Physica*, **18**, 378–86 (*June–July*, 1952).

A description is given of the present acceleration tube and ion-source in use with the 800 kV cascade-generator. The ion-source is of the magnetic type operating with cold emission ensuring reliability and low power consumption. The importance is stressed of good focusing and experiments are described to meet this requirement. A.

537.534.74

8263. Regular meson potentials in low energy proton–proton scattering. H. E. Hart and R. D. Hatcher. Letter in *Phys. Rev.*, **87**, 375 (*July* 15, 1952).

In the range < 3 MeV a potential of the type $[1 - \exp(-r/a_0)]\ [(e^2/r) - C(r/a)^{-1} \exp(-r/a)]$, $a_0 = e^2/mc^2$ can be made to agree with experiment with a corresponding to a meson mass of 274 m.

W. J. SWIATECKI

537.534.74

8264. Some data on the elastic scattering of 18·3 MeV protons. P. C. Gugelot. Letter in *Phys. Rev.*, **87**, 525–6 (*Aug.* 1, 1952).

The absolute differential cross-section for the elastic scattering of protons by Al, Fe, Ni, Cu, Ag, Sn and Pt, at 18·3 MeV, was measured using scintillation counters. The results are presented in tabular form and graphically, and compared with those of other workers and theoretical predictions. J. HUGHES

537.534.74

8265. Proton–proton scattering at 147 MeV. J. M. Cassels, T. G. Pickavance and G. H. Stafford. *Proc. Roy. Soc. A*, **214**, 262–72 (*Aug.* 21, 1952).

An external proton beam from the 110-in Harwell cyclotron has been used to investigate proton–proton scattering at 147 MeV. The angular distribution of the scattering has been studied from 25 to 90° and found to be isotropic, within the limits of error. The absolute differential cross-section for scattering at 90° has been measured in two ways and found to be $4{\cdot}94 \pm 0{\cdot}28$ millibarns. The results can also be used to find the $C^{12}(p,pn)C^{11}$ cross-section at 142 MeV.

A.

537.534.74

8266. Proton–proton scattering at 5 MeV by a coincidence method. R. O. Bondelid, C. H. Braden, M. E. Battat and P. Bohlman. *Phys. Rev.*, **87**, 699–702 (*Sept.* 1, 1952).

The scattering of 5-MeV protons by protons was examined by a coincidence method. Particular attention was given to the absolute value of the differential cross-section at 45° in the laboratory system. The differential cross-sections at other angles were determined relative to the cross-section at 45°. The S-wave phase shift calculated from the observed cross-section at 45° agrees, within the experimental error, with that from other experiments in this energy range. No indication of a P-wave effect was observed. A.

537.534.74

8267. The differential cross section for the scattering of 9·48-MeV protons by helium. T. M. Putnam. *Phys. Rev.*, **87**, 932–40 (*Sept.* 15, 1952).

The angular distribution of protons scattered by He has been measured at 9·48-MeV incident proton energy in the angular range of 10° to 172·5° in the laboratory system. Ilford C-2 photographic emulsions were used for detecting the scattered particles. The geometry of the multiplate scattering chamber and the accuracy of the construction was such that the results obtained have a relative accuracy within the counting statistics and an absolute accuracy to $\pm$ 3%. The results are given in terms of the differential cross-section per unit solid angle in the centre-of-mass system and are compared to the results at other energies. A.

537.534.74 : 778.34

8268. On the utilization of multiple scattering measurements. D. S. Schonland. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 640–56 (*Aug.*, 1952).

The determination of the product pv for particles leaving tracks in photographic emulsions is discussed on the basis of measurements of the scattering in the tracks made by the "coordinate" method (Fowler, 1950), allowing for errors of measurement due to grain size. The use of Fowler's method with the comparatively large interval lengths used in practice is shown to be justifiable in spite of its neglect of much information contained in the track. (This neglect increases the root mean square error in the estimation of the scattering over the minimum attainable error by a factor less than approximately 2·6.) A possible method of estimating pv, which approximates to the "best possible," based on the use of mean squares, is considered, and the root mean square relative error in the estimation found, the necessity for cutting off the scattering distribution at large angles being taken into account. A possible method of estimation based on the use of mean moduli is also discussed. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542 : 621.387.42

8269. The principles and method of operation of some modern gas-filled counter tubes. A. B. Thomas. *Proc. Instn Radio Engrs Aust.*, **13**, 311–15 (*Aug.*, 1952).

A summary of the principles used in the Remtron, Dekatron and Nomotron tubes. A. H. W. BECK

537.542

8270. Reabsorption of scattered radiation in an ionization chamber. H. Tellez-Plasencia and P. Théron. *J. Phys. Radium*, **13**, 297–8 (*May*, 1952) *In French.*

Previous calculations [Abstr. 4013 (1949)] of the reabsorption of fluorescent radiations emitted and reabsorbed in an ionization chamber are applied to the reabsorption of radiation modified by the Compton effect. The result is important when photo-electric absorption is small compared with scattering.

F. LLEWELLYN JONES

537.542

8271. Solid and liquid scintillation counters. G. T. REYNOLDS. *Nucleonics*, **10**, 46–53 (*July*, 1952).

The uses for which scintillation counters possess special advantages are outlined and important properties of scintillation materials are discussed. Experimental data on the energy response of phosphors, particularly the behaviour of organic crystals and solutions with heavily ionizing particles is examined in the light of current theories. The mechanism of the scintillation process is discussed both for organic and inorganic phosphors.

L. R. SHEPHERD

537.542

8272. A receiver of high effective absorption for penetrating radiation. R. FRÉRICHS. Letter in *J. Appl. Phys.*, **23**, 697–8 (*June*, 1952).

High-energy radiations are detected by the dielectric changes they produce in certain phosphors. The effective absorption of the system is improved by using many thin layers of phosphor sandwiched between a series of metal electrodes. G. F. J. GARLICK

537.542

8273. Spark counter for the detection of α-particle contaminations and for the measurement of thermal neutron dosages. P. SAVEL. *C.R. Acad. Sci.* [*Paris*] **234**, 2596–8 (*June* 30, 1952) *In French.*

Describes a wire–plate spark counter which, with a suitable boron plate, may be used to measure slow neutron fluxes. The sensitivity (200 counts/min ≡ 1250 neutrons/cm²/sec) was such that (1/100 × tolerance dose of neutrons) could be measured in a few minutes. α-active contaminations may similarly be measured and in a particular case the counter was about 10% efficient. J. D. CRAGGS

537.542

8274. The use of a spark counter for the study of the fission of uranium. P. SAVEL. *C.R. Acad. Sci.* [*Paris*] **235**, 156–7 (*July* 16, 1952) *In French.*

Describes the use of a 13 wire counter to detect fission fragments, either in a pile or with a uranium sample placed with the counter under a paraffin block and irradiated with neutrons. J. D. CRAGGS

537,542 : 621.318.572

8275. Design and operation of a "mean deviation meter". L. H. GREENBERG AND W. W. HAPP. *Canad. J. Phys.*, **30**, 317–28 (*July*, 1952).

An instrument was constructed and calibrated to measure the mean deviation of the counting rate from a series of pulses that are not uniformly spaced. Two resistance–capacitance "memory" circuits measure the instantaneous and the average counting rates. A rectifier bridge circuit is used to compute the relative deviation. Over a large part of the range the response is linear and reproducible within 5% for full scale deflection. The instrument is used in conjunction with the counting of radioactive radiations; other uses are discussed. A.

537.542 : 621.318.572

8276. Statistics of the mean deviation meter. E. S. KEEPING AND W. W. HAPP. *Canad. J. Phys.*, **30**, 329–41 (*July*, 1952).

The mean deviation is evaluated for a number of distributions of a Poisson or similar type, such as arise with counters, scaling circuits, and in particular with the mean deviation meter described by Greenberg and Happ. The mean deviation for some distributions is fairly readily obtainable, but for the charge on a single tank circuit and also for the difference of charges on two tanks with different decay constants it is necessary to obtain the probability density. Exact expressions for these density functions are given, and also approximations from which the mean deviation can be calculated. A.

537.542 : 621.318.572 : 621.385.5

8277. The 6BN6 gated-beam tube as a fast coincidence circuit. J. FISCHER AND J. MARSHALL. *Rev. Sci. Instrum.*, **23**, 417–20 (*Aug.*, 1952).

The performance of the 6BN6 gated-beam tube as a fast coincidence circuit for short positive pulses is investigated experimentally. Design considerations are discussed and curves of performance are shown. Resolving times better than 3×10^{-10} second have been observed with pulses from a mercury-switch pulser. The circuit is simple and reliable in operation. It has been applied to coincidence measurement of pulses from photomultipliers. A.

537.542

8278. A rear illuminated cloud chamber. R. R. RAU. Note in *Rev. Sci. Instrum.*, **23**, 443–5 (*Aug.*, 1952).

Constructional details and general arrangement diagrams are given for a chamber designed for high-altitude balloon flight. F. R. HOLT

537.543 : 621.3.011.21 : 621.385.2

8279. The admittance of a diode with a retarding field. J. J. FREEMAN. *J. Appl. Phys.*, **23**, 743–5 (*July*, 1952).

The contribution of space charge to the admittance of a diode with a retarding field is calculated by computing the instantaneous electronic current induced in an external circuit. A discussion of the variation of the susceptance of a typical diode with frequency is given. A.

537.543 : 621.317.34 : 621.385.3

8280. Space charge reduction of low frequency fluctuations in thermionic emitters. T. B. TOMLINSON. *J. Appl. Phys.*, **23**, 894–9 (*Aug.*, 1952).

The methods of measuring the space charge reduction factor for shot noise are briefly reviewed, and attention is drawn to the difficulties of making a similar measurement for flicker noise. An indirect qualitative test is described in which a triode is used both in normal manner and as a diode under retarding field conditions. Noise measurements at a high and a low frequency show that the effect of space charge on flicker noise exceeds that for shot noise. The diode results are used to estimate the value of the flicker noise reduction factor which is then seen to have a value less than the corresponding shot noise reduction factor at all current levels. A.

537.543 : 631.387

8281. The initial conduction interval in high speed thyratrons. J. B. WOODFORD, JR, AND E. M. WILLIAMS. *J. Appl. Phys.*, **23**, 722–4 (*July*, 1952).

The initial conduction interval in thyratrons, or time interval during which the major rise in current occurs, is shown to be dependent on two parameters. The first of these is dependent on tube construction

and the second on circuit elements. It is shown that both factors are significant in operation of hydrogen thyratrons in millimicrosecond switching service. A.

IONIZATION . THERMIONICS 537.56/.58

537.564

8282. The re-charging of negative ions Na^-, K^-, O^-, OH^- and O_2^- on oxygen molecules. V. M. Dukelskiĭ and E. Ya. Zandberg. *Dokl. Akad. Nauk SSSR*, **82**, 33–6 (*No.* 1, 1952) *In Russian.*

The capture of electrons by an ion beam passing through O_2 gas at low pressures was studied by analysing the resulting mixture of ions and electrons with electric and magnetic fields. The cross-sections (10^{-15}–10^{-16} cm^2) show an inverse correlation with the difference between the electron affinities of the beam ions and the gas molecules. W. J. Swiatecki

537.564

8283. The photo-ionization cross section of methane. A. Dalgarno. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 663–7 (*Aug.*, 1952).

The photo-ionization cross-section of methane is calculated using self-consistent wave functions. The value at the spectral head (105 850 cm^{-1}) is found to be $9{\cdot}4\times10^{-17}$ cm^2. An approximate general formula is employed to obtain results in a wave number range up to 200 000 cm^{-1} and the associated oscillator strength is computed. It is pointed out that exchange effects probably reduce the cross-section. With the aid of the general formula an estimate is also made of the photo-ionization cross-section of A. A.

537.565

8284. The movement of ions in strong electric fields. M. Pauthenier and R. Challande. *C.R. Acad. Sci.* [*Paris*] **235**, 28–30 (*July* 7, 1952) *In French.*

Gives data on the mobility of positive and negative ions in damp and dry air for values of the electric field $\sim$ 3000–4000 V/cm. The latter quantities were measured with a hot probe. J. D. Craggs

537.565

8285. Motion of gaseous ions in a strong electric field. II. G. H. Wannier. *Phys. Rev.*, **87**, 795–8 (*Sept.* 1, 1952).

For Pt 1, see Abstr. 7044 (1951). The object is to elucidate the nature of the random motion of an ion about its drift. It is shown that this motion can be described as a diffusion with a diffusion tensor axially symmetric about the field. If the mean free time between the collisions of an ion with molecules is independent of speed, then explicit expressions may be deprived for the two diffusion coefficients; these expressions are written down without proof; they are connected with the mobility by a natural extension of the Einstein relation. The longitudinal diffusion coefficient is computed numerically for the hard sphere model, high field, and mass ratio 1. Finally, it is shown how approximate formulae of wider validity can be inferred from the ones obtained. A.

538.565.5 : 534.14 : 621.3.018

On electric and acoustic transient phenomena. *See Abstr.* 8015

537.568 : 523.755

Ionization and recombination processes in a plasma and the ionization formula for the solar corona. *See Abstr.* 7893

537.583

8286. An experimental investigation of the oxide cathode. N. D. Morgulis and Ya. P. Zingerman. *Dokl. Akad. Nauk SSSR*, **81**, 783–5 (*No.* 5, 1951) *In Russian.*

Using a special technique with $4\times40\,\mu$ Pt ribbon embedded in the oxide coating, the p.d. in the coating was found to have 3 components: (*a*) a slight contact p.d. at the Ni base to oxide surface; (*b*) a "volume" p.d.; (*c*) a relatively larger "sub-surface" p.d. adjacent to the emitting surface, and having special characteristics determining the thermionic behaviour of the coating, such as gradual loss of emission with use. F. Quelon

537.583

8287. Spectral dependence of thermionic emission with activation from (Ba–Sr)O cathodes over the visible region. T. Hibi and K. Ishikawa. Letter in *Phys. Rev.*, **87**, 673 (*Aug.* 15, 1952).

Describes experiments which demonstrate that the peak intensities of the spectral distribution, in the visible range, depend on the state of activation. This proves the hypothesis that trapping levels exist between the filled band and the conduction band. A. H.-W. Beck

537.583 : 621.385.032.216

8288. An investigation of the thermoelectric power within the oxide cathode. P. A. Zeltsman, N. D. Morgulis and V. S. Yagovdik. *Zh. Tekh. Fiz.*, **21**, 1035–40 (*No.* 9, 1951) *In Russian.*

A review (with 8 Soviet and other references) of results obtained by placing probes in the coating, together with some new results, graphically presented, of the authors' experiments using this technique, on the relationships between thermoelectric power, electric conduction, thermionic emission, and temperature, within actual BaO cathodes. Revision of the current energy models of the oxide cathode, necessitated by new data (e.g. the existence of a component of hole conduction) will shortly be the subject of a further publication. F. Quelon

537.585

8289. Effect of various gases on potassium ion emission from hot platinum. C. F. Robinson, P. D. Zemany and E. L. Brady. Letters in *J. Chem. Phys.*, **20**, 1329 (*Aug.*, 1952).

COSMIC RAYS 537.591

537.591 : 523.165

On the possible relation of galactic radio noise to cosmic rays. *See Abstr.* 7884

537.591.1

8290. The ionization spectrum of the hard component of cosmic radiation at sea level. A. G. Meshkovskiĭ and V. A. Shebanov. *Dokl. Akad. Nauk SSSR*, **82**, 233–6 (*No.* 2, 1952) *In Russian.*

This was measured for mesons in two energy ranges (23–66 cm Pb and $>$ 66 cm) using a stilbene

scintillation counter. Comparison of ionizations in the two ranges shows that the "density effect" due to the polarization of the medium by the mesons is present. Qualitative agreement of the spectrum with Landau's theory is obtained but fluctuations about the mean are still 50% greater than calculated. W. J. SWIATECKI

537.591.1

8291. On the nucleonic components producing large cosmic-ray bursts under thick shield. T. KAMEDA AND M. WADA. *Progr. Theor. Phys.*, **7**, 1–14 (*Jan.*); *Erratum*, 422–3 (*April*, 1952).

By analysing the size-frequency distributions of large cosmic-ray bursts obtained at three stations with ion chambers, it is concluded that: (*a*) about 10% of the total bursts at sea level are those induced by *N*-rays, and the portion of them decreases with increasing size; (*b*) absorption mean free path of burst-producing *N*-rays is 120 g/cm² in air, and decreases with increasing size, approaching to collision mean free path of air. Moreover, comparison of these results with others shows that the absorption mean free path of burst-producing *N*-rays near sea level is not the same as that at high altitude, but is elongated. Burst production is discussed in connection with the results. A.

537.591.1

8292. The angular distribution and attenuation of the star-producing component of cosmic rays. N. C. BARFORD AND G. DAVIS. *Proc. Roy. Soc. A*, **214**, 225–37 (*Aug.* 21, 1952).

Some properties of cosmic rays at 3570 m have been studied by observing nuclear disintegrations in G5 emulsion under Pb absorbers. Good geometrical definition was ensured by making these absorbers in the form of inverted Pb cones of various half-angles. The nuclear cascade process is such that the overall attenuation in Pb of the star-producing component increases with energy, the attenuation length varying from 370 ± 30 to 210 ± 70 g cm^{-2} over the range of energy responsible for the stars examined. Interpretation of the results to give the angular distribution of the star-producing radiation depends upon the nature of the cascade process. However, it is certainly more collimated than a $\cos^2\Theta$ steradian^{-1} distribution, where Θ is the zenith angle, and may be of the form $\cos^4\Theta$ steradian^{-1} for the high-energy component. For the charged component alone a direct measurement gave $\cos^{5\pm1}\Theta$ steradian.$^{-1}$ The rate of production in emulsion under no absorber of all stars with three or more heavy prongs is $17{\cdot}0 \pm 0{\cdot}4$ cm^{-3} day^{-1}. A.

537.591.1

8293. The angular and lateral distribution functions for the nucleon component of the cosmic radiation. H. MESSEL AND H. S. GREEN. *Phys. Rev.*, **87**, 738–47 (*Sept.* 1, 1952).

A method is developed, whereby the angular and radial distribution functions for the nucleon component of the cosmic radiation in the atmosphere may be obtained in terms of the moments of the distributions. Essentially the method consists of an expansion of the unknown distribution functions in a series of derivatives of the Dirac delta-function, whose coefficients are identified with the angular and radial moments. The method gives results identical with those obtained by a more tedious procedure, and is of general applicability in reconstructing distribution functions when only their moments are known. The angular and radial distribution functions are found for various initial conditions and numerical results given for the case of an integral primary proton power law spectrum with exponent $\gamma = 1{\cdot}1$. Variation of atmospheric density with height is taken into account. Using a form of the differential cross-section for nucleon–nucleon collisions, $R + S'\cos^2\bar{\theta}$ in the centre-of-mass frame of reference, predicted by most field theoretic treatments, it is shown that the calculated results are in disagreement by an order of magnitude with experimental data. The various assumptions on which the theory is based (power law, homogeneous form of total cross-section, etc.) are then critically examined. It is concluded that the theory can be reconciled with experiment only when the number of scattered particles decreases exponentially from the direction of motion of the incident particle in the laboratory frame of reference. Using this result, the new angular and radial distribution functions are then calculated and found to be given at sea level essentially by $\exp[-166U(1-C)]$ and $\exp(-3{\cdot}72U^{\frac{1}{2}}r)$, respectively, for particles of energy greater than U BeV, where C is the cosine of the angle with the shower axis and r is the distance in kilometers from the shower axis. The half-value of the radial distribution occurs at a distance of 92 m from the shower axis. A.

537.591.1

8294. Mean free path of the high energy *N* component of cosmic radiation. R. R. BROWN. *Phys. Rev.*, **87**, 999–1002 (*Sept.* 15, 1952).

The mean free path of charged particles that produce penetrating showers has been measured in C, S and Fe. Preliminary measurements with C were carried out at 130 m elevation and the mean free path obtained was 89 ± 12 g/cm². Measurements at 2765 m elevation gave mean free paths in C, S and Fe of 65 ± 5, 76 ± 7 and 115 ± 12 g/cm², respectively. The C data were used to get an estimate of the mean free path in nuclear matter of high energy nucleons. A.

537.591.15

8295. Interactions of pions originating in penetrating showers. R. L. COOL AND O. PICCIONI. Letter in *Phys. Rev.*, **87**, 531–3 (*Aug.* 1, 1952).

Penetrating shower secondaries were passed through a magnetized Fe block and an absorber. Their deflection in the Fe, and their behaviour in the absorber were studied using G.M. counters in a 196-channel hodoscope arrangement. The differential energy spectrum of the secondaries is given up to 2·5 BeV and their multiple scattering in ½ in Pb found to agree with that predicted by the spectrum. The μ-meson background was determined using thick absorbers, the remainder being taken as π-mesons. The total interaction cross-sections in C and Pb were found to be ¾ geometric, for π-mesons no significant difference being found for +ve or −ve particles. C–paraffin difference measurements give a figure for the elastic proton interaction of $\sigma(\pm) = 1 \pm 1 \times 10^{-26}$ cm². E. P. GEORGE

537.591.15

8296. The energy spectrum of the electrons in extensive cosmic ray showers. C. MILONE. Letter in *Phys. Rev.*, **87**, 680 (*Aug.* 15, 1952).

The absorption in up to 60 g/cm² of Pb or water of the extensive shower particles was studied. The results indicate an integral spectrum $\propto (E + E_c)^{-\alpha}$, with α of order 0·5–0·6. Difficulties are met if one assumes the showers are produced by primary electrons, but not if they are regarded as products of nucleon cascades. E. P. GEORGE

537.591.15

8297. Spatial distribution of penetrating particles in cosmic ray atmospheric showers. L. KH. EĬDUS, M. I. ADAMOVICH, I. A. IVANOVSKAYA, V. S. NIKOLAEV AND M. S. TULYANKINA. *Zh. Eksper. Teor. Fiz.*, **22**, 440–7 (*No.* 4, 1952) *In Russian.*

This was studied using a counter hodoscope. The proportion of penetrating particles was found to increase proportionally to the distance from the shower axis. At sea level, the penetrating particles constitute ~10% of the total number of shower particles, and account for more than half of the total energy. The percentage of penetrating particles decreases with increase in the total number of shower particles. Arguments are given for the existence of a multiple-core structure. E. P. GEORGE

537.591.15 : 518.5

8298. An analog computer as an aid to shower theory calculations. L. ALTMAN. *Rev. Sci. Instrum.*, **23**, 382 (*July*, 1952).

The trigonometric equation relating the variables in the multiple scattering problem may be set up using sine-cosine generators and standard amplifiers, and simply solved, to first degree accuracy, by a null balance method. A. J. KENNEDY

537.591.5

8299. Cosmic rays and the sun's magnetic field. *Nature* [*Lond.*] **170**, 62–4 (*July* 12, 1952).

Apparent absence of low energy cosmic ray primaries. J. A. VAN ALLEN AND S. F. SINGER. (62–3).

From a critical survey of evidence on the intensity of cosmic rays above and near the top of the atmosphere, at high latitudes, it is concluded that low-energy primaries are absent to a significant extent, and that, near geomagnetic latitude 58°, there is a flattening of the primary momentum spectrum ("knee").

Diurnal variation of cosmic rays and the sun's magnetic field. S. F. SINGER. (63–4).

If the latitude cut-off described above is due to the sun's magnetic field, a dipole moment of $0{\cdot}65 \times 10^{34}$ gauss cm³, is indicated. It is shown that with this value for the dipole moment the cosmic ray diurnal variation would still be almost undetectably small. Even neglecting effects of conducting interplanetary matter, consideration of the experimental results on diurnal variation and latitude knee does not support assertions [Abstr. 3244, 5094 (1950)] that cosmic ray experiments prove the solar moment $< 0{\cdot}6 \times 10^{33}$ (i.e. field < 1–2 gauss). J. HUGHES

537.591.5

8300. Azimuthal variation of cosmic radiation for zenith angle 40° at λ = 19N. B. BHOWMIK AND G. S. BAJWA. Letter in *Phys. Rev.*, **87**, 530–1 (*Aug.* 1, 1952).

The variation has been measured at sea level using counter telescopes with 10 cm lead absorber. The results are found to be in good agreement with the calculations of Lemaitre and Vallarta and lead to an exponent of 1·45 for the primary energy spectrum. H. ELLIOT

537.591.5

8301. Correlation of cosmic-ray ionization measurements at high altitudes, at sea level, and neutron intensities at mountain tops. H. V. NEHER AND S. E. FORBUSH. *Phys. Rev.*, **87**, 889–90 (*Sept.* 1, 1952).

Although fluctuations in cosmic rays have been measured at sea level and high altitudes for a number of years, no serious attempt seems to have been made to correlate the two. As a result of a rather long series of balloon flights in the summer of 1951 it now becomes possible to correlate ionization measurements at high and low altitudes. Recent neutron intensity measurements during the same period by Simpson *et al.* permit a further comparison with this component. There seems to be a good correlation, during this period of observation, between the fluctuations as measured in (1) the ionization at 70 000 ft over North Dakota, (2) the meson component at Cheltenham, Maryland, (3) the meson component at the geomagnetic equator, and (4) the neutron component at mountain tops in Colorado and New Mexico. A.

537.591.8

8302. Note on very large cosmic-ray stars. II. Y. YAMAGUCHI. *Progr. Theor. Phys.*, **6**, 529–32 (*July–Aug.*, 1951).

For Pt I, see Abstr. 6614 (1950). A new mechanism of emission of nuclear fragments from highly excited nuclei is discussed upon the basis of the liquid drop model. A.

537.591.8

8303. Nuclear interaction of μ-meson. H. FUKUDA, Y. FUJIMOTO AND M. KOSHIBA. *Progr. Theor. Phys.*, **6**, 788–800 (*Sept.–Oct.*, 1951).

The experimental results concerning nuclear events in cosmic rays underground, obtained by George and Evans by means of nuclear emulsions [Abstr. 1169 (1951)], were found to be in rather good agreement with the theoretical calculation, where the electromagnetic interaction of μ-mesons with nucleons were treated in detail by Feynman–Dyson's procedure. A.

537.591.8

8304. A narrow angle pair of particles produced in hydrogen. A. B. WEAVER, E. A. LONG AND M. SCHEIN. Letter in *Phys. Rev.*, **87**, 531 (*Aug.* 1, 1952).

Discusses a cloud chamber photograph of an event which occurred in liquid hydrogen at sea level. Three tracks were observed in the chamber, one of which stops in a 2 cm lead plate and is believed to be a knock-on electron. The other two, which originate from a point in the liquid hydrogen above the chamber, have an angular separation of ~4° and penetrate the plate without multiplication. It is suggested that the event may represent a nuclear interaction by a high energy μ-meson. H. ELLIOT

537.591.8

8305. An unusual meson induced star. W. F. FRY AND J. J. LORD. Letter in *Phys. Rev.*, **87**, 533–4 (*Aug.* 1, 1952).

Scattering measurements and gap-counting indicate the meson has mass $\sim 1000 m_e$. The star has 3 prongs, of which one is probably and one possibly a π-meson, the third is a low energy proton. An interpretation in terms of nuclear capture of a negative τ or κ meson is suggested. E. P. GEORGE

537.591.8

8306. Ionization by cosmic ray mesons in argon. G. W. MCCLURE. Letter in *Phys. Rev.*, **87**, 680 (*Aug.* 15, 1952).

The size distribution of pulses due to the passage of Pb-filtered mesons through a fast ion chamber was found to be close to that expected. E. P. GEORGE

537.591.8

8307. Bursts in material of low atomic number. F. E. DRIGGERS. *Phys. Rev.*, **87**, 1080–90 (*Sept.* 15, 1952).

A large ionization chamber has been used to obtain an integral burst-size/frequency distribution by amplifying and recording the electron pulses produced by bursts. A comparison of the integrated burst rate from the upper hemisphere with that produced by primaries with a small zenith angle permitted an estimate of the burst rate resulting from interactions of the N component. Calculations were made of the expected burst distributions arising from the electromagnetic interactions (bremsstrahlung, knock-on, and direct pair production) of spin 0 and spin $\frac{1}{2}$ μ-mesons. About $\frac{1}{2}$ of the bursts observed under 400 g cm^{-2} of sand-lime brick and concrete at sea level were attributed to interactions of the N component. The remaining burst rate agreed with the rate calculated for spin $\frac{1}{2}$ to within the estimated uncertainty of the comparison—about 20%. Lack of quantitative information concerning the nuclear interactions of μ-mesons prevents an estimation of the actual electromagnetic cross-sections. The expected Z-dependence of μ-meson bursts was roughly confirmed by a comparison with results obtained elsewhere under material of higher Z. A.

MAGNETISM 538

538

8308. Some post-war developments in magnetism. L. F. BATES. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 577–94 (*Aug.*, 1952).

A survey is given of some of the more outstanding developments in magnetism during the post-war years, including the great extension of our knowledge of the ferromagnetic domain through the theoretical work of Néel and others and by the systematic use of the Bitter powder figure techniques; the main ferromagnetic, paramagnetic and nuclear resonance phenomena and experiments on the diffraction of neutrons by antiferromagnetic crystals are also described. A.

538.114

8309. The spin-wave theory of antiferromagnetics. R. KUBO. *Phys. Rev.*, **87**, 568–80 (*Aug.* 15, 1952).

The spin-wave theory of antiferromagnets, recently studied by Anderson for the absolute zero of temperature, is examined here for finite temperatures to derive the thermodynamic properties of antiferromagnets at low temperatures. Somewhat differently from Anderson's semiclassical treatment, the present theory has used the formulation devised by Holstein and Primakoff, upon which the thermodynamic quantities are derived quantum-statistically. The parallel susceptibility is shown to be proportional to T^2, while the perpendicular susceptibility is independent of the temperature in the first approximation but decreases with increase in temperature if calculated in the second approximation. A tentative discussion is given of the nature of the divergences which arise in the simple formulation of spin-wave treatments in the absence of any kind of anisotropy. A.

538.114 : 548.7

8310. On the crystal statistics of two-dimensional Ising ferromagnets. T. YAMAMOTO. *Progr. Theor. Phys.*, **6**, 533–42 (*July–Aug.*, 1951).

Statistical problems of two-dimensional Ising ferromagnets of various lattice types are reduced to those of square nets so that direct applications of Onsager–Kaufman's method are allowed. Most of the physically interesting lattices can be treated systematically, but lattices with longer period of translational symmetry could hardly be handled. The triangular and the honeycomb lattices are treated simultaneously, and particularly their dual relation is given in the most general form. A.

538.123 : 621.3.013 : 621.316.73

8311. A magnetic potential divider. G. HINMAN AND F. CRANE. *Rev. Sci. Instrum.*, **23**, 438–40 (*Aug.*, 1952).

A type of magnetic potential divider for shaping the magnetic field near a pole edge is discussed. This method of terminating a pole has been applied to a β-ray spectroscope magnet recently constructed at Carnegie Institute of Technology. The maximum usable radius has been increased by about 15% over the value without it. The method is applicable to many low field magnets. A.

538.221

8312. Ferromagnetism. U. M. MARTIUS. *Progress in metal physics, vol.* 3, *pp.* 140–75 (1952) [See Abstr. 8617 (1952)].

A review, concerned mainly with domains. A discussion of the various contributions (exchange, anisotropy and strain, magnetostatic) to the total domain energy is followed by a discussion of the characteristics of domain boundaries and the configuration of domains in single crystals. Recent powder pattern experiments are described. The processes of magnetization in single crystals are discussed and the theory of coercivity is reviewed. Magnetic effects in polycrystalline materials are considered, particular attention being paid to the influence of grain boundaries and the influence of mechanical properties on the law of approach to saturation. 64 references. E. P. WOHLFARTH

538.221

8313. On the thermal and thermoelectric properties of ferromagnetic metals. A. I. REZANOV. *Dokl. Akad. Nauk SSSR*, **82**, 885–7 (*No.* 6, 1952) *In Russian.*

In the first approximation the *s*-electrons (external electrons) are in a lattice of a crystal, under the influence of a quasi-magnetic "exchange" field. This leads to a division of external electrons into two groups, according to the orientation of their respective magnetic moments. It follows, thus, that ferromagnetic metals are bound to show anomalies of their properties near Curie's point, where spontaneous magnetization suffers abrupt changes with temperature. Using the conventional scheme of the kinetic equation and previous research by Vonsovsky, formulae for Thomson's coefficient and Peltier's heat are then derived. It follows from the formulae that the temperature behaviour of ferromagnetic "additions" is determined on the whole by the square of the magnitude of spontaneous magnetization, while the corresponding thermal coefficients have maxima near Curie's point. INDEX AERONAUTICUS

538.221

8314. Anti-ferromagnetic resonance in copper chloride. J. UBBINK, J. A. POULIS, H. J. GERRITSEN AND C. J. GORTER. *Physica*, **18**, 361–8 (*June–July*, 1952).

The resonance absorption of $CuCl_2 . 2H_2O$, in the antiferromagnetic state is investigated at a frequency of about 9400 Mc/s at different temperatures with different orientations of the external field with respect to the crystalline axes. In general two lines are found when the external field is parallel to the *a*-axis. When the external field is rotated towards the *b*-axis the lines approach each other, coalesce and disappear. When the external field is rotated towards the *c*-axis the lines move to higher field values. A.

538.221

8315. Behaviour of a single crystal of $CuCl_2 . 2H_2O$ near the Néel temperature. N. J. POULIS AND G. E. G. HARDEMAN. *Physica*, **18**, 429–32 (*June–July*, 1952).

The behaviour of the proton magnetic resonance in a single crystal of $CuCl_2 . 2H_2O$ is studied near the Néel temperature T_N. It is found that T_N is lower when the magnetic field H_0 is along the *a*-axis than when H_0 is along the *b*-axis of the crystal. In fields below the threshold field ($H_{thr.}$) this difference $T_{Nb} - T_{Na}$ has a maximum of about 0·015°K, while above $H_{thr.}$ this difference is of the order of 0·041°K. A.

538.221

8316. Rare earth ferrites with two ferromagnetic Curie points. H. FORESTIER AND G. GUIOT-GUILLAIN. *C.R. Acad. Sci.* [*Paris*] **235**, 48–50 (*July* 7, 1952) *In French.*

Previous work on the temperature variation of the magnetization of the substances $Fe_2O_3 . M_2O_3$ [Abstr. 6642 (1952)] is extended, with M = Y, Sm, Gd, Tm, Yb, for all of which there are apparently two Curie points after sufficient annealing, e.g. 295° and 405°C for M = Sm. This finding is tentatively explained. E. P. WOHLFARTH

538.221

8317. The influence of anisotropy on ferromagnetic relaxation. N. BLOEMBERGEN AND S. WANG. Letter in *Phys. Rev.*, **87**, 392–3 (*July* 15, 1952).

An extension of earlier work [Abstr. 3704 (1952)] to other samples of nickel ferrite, other ferrites and lower temperatures. The curves giving μ'' and M_z for spherical polycrystalline specimens of $MnO.ZnO.Fe_2O_3$ differ markedly from those for a single crystal and are in better agreement with the theoretical prediction $\mu'' \propto M_z$. Results for disk-shaped specimens, where the resonance condition depends on M_z via the demagnetizing factors, are also given. E. P. WOHLFARTH

538.221

8318. Anisotropy in the antiferromagnetic MnF_2. F. KEFFER. *Phys. Rev.*, **87**, 608–12 (*Aug.* 15, 1952).

The major part of the anisotropy in the paramagnetic susceptibility of MnF_2 above the Curie point, as measured by Stout and Griffel, can be accounted for by magnetic dipole interactions. These interactions affect the anisotropy in different ways above and below the Curie point and lead to an anisotropy field of the order of 8800 oersteds at 0°K. Other sources of anisotropy in antiferromagnetics are discussed, in particular that due to crystalline fields which is also present in magnetically dilute paramagnetic salts. The anisotropy field below the Curie point can be measured by antiferromagnetic resonance. It is predicted that this will require wavelengths of 1 mm at 0°K increasing to perhaps 2 mm at $0 \cdot 97 T_c$. Or one may use centimetre waves and static fields of $1 \cdot 0 \times 10^5$ oersteds at 0°K increasing to perhaps $1 \cdot 7 \times 10^5$ oersteds at $0 \cdot 97 T_c$. A.

538.221

8319. The gyromagnetic ratios of the ferromagnetic elements. G. G. SCOTT. *Phys. Rev.*, **87**, 697–9 (*Sept.* 1, 1952).

The gyromagnetic ratios for the three ferromagnetic elements have been determined by means of a technique involving a sensitive torsional pendulum. The final values obtained, in terms of the mass-to-charge ratio of the electron, are: Fe, $1 \cdot 028 \pm 0 \cdot 001$; Co, $1 \cdot 068 \pm 0 \cdot 004$; and Ni, $1 \cdot 078 \pm 0 \cdot 002$. A.

538.221

8320. Gyromagnetic ratios of iron, cobalt, and many binary alloys of iron, cobalt, and nickel. S. J. BARNETT AND G. S. KENNY. *Phys. Rev.*, **87**, 723–34 (*Sept.* 1, 1952).

Gyromagnetic ratios for Fe, Co and many binary alloys of Fe, Co and Ni were determined by measurements on the Einstein–de Haas effect such as made in the Norman Bridge Laboratory previously. Improvements were made in the method of eliminating large quadrature torques, in the method of reducing disturbances due to the vibrations of the building, in the method of frequency control, in the design of the square wave commutator, and in the design of the rotors. For each series of binary alloys the gyromagnetic ratio was found to vary linearly, or nearly linearly, with the concentration. For the small number of these materials studied in the Norman Bridge Laboratory previously there is good agreement between the new results and the older, both those

obtained by the Barnett effect and those obtained by the Einstein–de Haas effect. For the three series of alloys the ranges of pe/m are approximately as follows: Fe–Co, 1·03 to 1·08 or 1·09; Fe–Ni, 1·03 to 1·05; and Ni–Co, 1·05 to 1·08 or 1·09. A.

538.221 : 548.0

8321. Anisotropy of the coercive force in monocrystals of an iron–silicon alloy. V. V. DRUZHININ AND R. I. YANUS. *Zh. Tekh. Fiz.*, **22**, 848–57 (*No.* 5, 1952) *In Russian.*

An experimental investigation was carried out on the anisotropy of the coercive force in monocrystalline disks of an alloy of Fe with 3% Si, cut out of large crystallites in sheets of KhVP transformer steel. The face of the dodecahedron of the crystal lattice was nearly parallel to the face of the disks. It was found that the maximum of the coercive force in the crystallites of this material is in the direction of the digonal crystal axis, and not in that of the trigonal axis, as hitherto assumed according to Williams' limited observations. Small irregular stresses in the monocrystalline disks with the orientation indicated produce a reduction of the coercive force along the digonal and trigonal axes. B. F. KRAUS

538.221 : 548.7

8322. On the antiferromagnetism of single crystals. K. YOSIDA. *Progr. Theor. Phys.*, **6**, 691–701 (*Sept.–Oct.*, 1951).

The antiferromagnetism of a single crystal is considered, basing on the Van Vleck model, modified by introducing an anisotropy energy of one spin, arising mainly from the crystalline field of the surrounding anions. On this model are derived the anisotropy of the susceptibility above the Curie point, the temperature variation of the anisotropy constant below the Curie point and the field dependency of the susceptibility under a comparatively strong magnetic field. A.

538.222

8323. Thermomagnetic investigation of palladium–hydrogen and of alloys of palladium with diamagnetic metals. J. WUCHER. *Ann. Phys.* [*Paris*] **7**, 317–59 (*May–June*, 1952) *In French.*

Describes measurements of the temperature variation of the paramagnetic susceptibilities of Pd–H and of Pd-rich alloys with Cu, Ag, Au, Al, Ga, Sn, Pb, Sb between about 100° and 1000°K (for many alloys the temperature range is much more restricted). In most cases the results are summarized by giving values of the Curie constant and temperature, in some by giving the susceptibility values in full detail. The results, particularly the variation of C_M with composition, are interpreted on the basis of the "atomic model," but there is also some discussion of the applicability of the collective electron treatment [Abstr. 5176 (1950)]. E. P. WOHLFARTH

538.222

8324. The magnetic properties of aqueous solutions of cupric nitrate. P. BERTHIER, C. COURTY AND J. GAUTHIER. *C.R. Acad. Sci.* [*Paris*] **234**, 2525–7 (*June* 23, 1952) *In French.*

A continuation of previous work on copper salts in solution [Abstr. 3715 (1952)] giving $p_B = 1{\cdot}92$ for the Cu^{++} ion. E. P. WOHLFARTH

538.222

8325. The fine structure of resonance absorption of Mn^{++} in a rhombic crystalline field. H. KUMAGAI, K. ÔNO, I. HAYASHI AND K. KAMBE. Letter in *Phys. Rev.*, **87**, 374 (*July* 15, 1952).

The paramagnetic resonance spectrum of $Mn(CH_3COO)_2 . 3H_2O$ is shown to agree with the 2nd-order perturbation theory for a rhombic crystalline field. D. H. WHIFFEN

538.222

8326. Anomalous magnetic resonance absorption of Cu^{++}. H. KUMAGAI, H. ABE AND J. SHIMADA. Letter in *Phys. Rev.*, **87**, 385–7 (*July* 15, 1952).

Reports measurements on single crystals of $Cu(CH_3COO)_2 . nH_2O$ at 10 and 20 kMc/s, giving the variation of the resonance field with orientation relative to the static field. The results are inexplicable if the Cu^{++} ions are in the ^2D state and alternative explanations are given. E. P. WOHLFARTH

538.222

8327. Paramagnetic resonance and spin–lattice relaxation times in the copper Tutton salts. D. M. S. BAGGULEY AND J. H. E. GRIFFITHS. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 594–603 (*Aug.*, 1952).

Paramagnetic resonance absorption in single crystals of the Cu Tutton salts has been investigated at 3·10 cm wavelength between 90°K and room temperature. In salts diluted with Zn Tutton salt the hyperfine lines are clearly resolved at 90°K, but broaden and merge into one another as the temperature is raised. From these measurements the spin–lattice relaxation time τ can be estimated and is found to be about 2×10^{-9} sec. It is found that $1/\tau$ varies linearly with temperature between 150°K and 290°K. An investigation of the crystalline field in the Tutton salts shows that for the concentrated salts the field has a strong rhombic component above 150°K, whilst in the salts diluted with Zn to less than 1% Cu the crystalline field has tetragonal symmetry at 290°K, but the tetragonal axis lies in a plane perpendicular to that containing the tetragonal axis at 90°K. A.

538.22

8328. Magnetic shielding effects in compounds of vanadium. H. E. WALCHLI AND H. W. MORGAN. Letter in *Phys. Rev.*, **87**, 541–2 (*Aug.* 1, 1952).

Nuclear resonance measurements on V^{51} have been made in 11 compounds and in vanadium metal. Frequencies are given relative to Na^{23}, together with the observed line-widths and the result of a direct measurement of the V^{51} frequency ratio in $VOCl_3$ and $NaVO_3$. T. G. PICKAVANCE

538.222 : 536.212

8329. Paramagnetic relaxation in cesium titanium alum. J. EISENSTEIN. Letter in *Phys. Rev.*, **87**, 522 (*Aug.* 1, 1952).

Application of earlier work on the effect of finite thermal conductivity on relaxation phenomena [Abstr. 405 (1952)]. For CsTi alum the relaxation time is very short [Abstr. 9603 (1951)] and the conductivity effect is large enough to cause appreciable distortion of the χ'', χ' curves for a large pure single crystal. E. P. WOHLFARTH

538.222 : 539.133

8330. Preparation and magnetic susceptibility of an oxygen clathrate compound. D. F. EVANS AND R. E. RICHARDS. Letter in *Nature* [*Lond.*] **170,** 246 (*Aug.* 9, 1952).

Magnetic susceptibility measurements on an oxygen clathrate compound of β-quinol, in which 40–50% of the available spaces were filled, indicated little magnetic interaction between the oxygen molecules, a value of $\chi(O_2) = +109{\cdot}5\times10^{-6}$ at 17°C being obtained. G. I. W. LLEWELYN

538.24

8331. Spontaneous magnetization of nickel zinc ferrite as a function of the nickel zinc ratio. K. F. NIESSEN. *Physica,* **18,** 449–68 (*June–July,* 1952).

The reduced spontaneous magnetization of Ni Zn ferrite (magnetization at T, divided by that at $T = 0$) is determined as a function of the reduced temperature T^* (T, divided by the Curie temperature T_c) and of the Ni/Zn ratio f, defined by the following expression for the ratio between the numbers of Ni and Zn ions: $\mathrm{Ni} : \mathrm{Zn} = f : (1-f)$. In the case $T^* \ll 1$ and in the case $T^* = 1 - \Delta$ ($\Delta \ll 1$), formulae for the reduced magnetization are given, holding for high values of f, for instance $\frac{1}{2} < f < 1$. For intermediate values of T^* a graphical method must be used. The results are compared with the experimental curves of Guillaud and Roux, representing the reduced magnetization as a function of T^* when several ferrites with a different Ni/Zn ratio are considered, especially at low and intermediate values of T^*. These curves diverge in a typical way. This can be explained qualitatively. For the Ni ions in nickel ferrite we are obliged to assume that, at $T^* = 0{\cdot}3$, 4% occupy tetrahedral interstices instead of octahedral interstices. A.

538.24 : 537.312.62

8332. The magnetic properties of superconducting alloys of indium and thallium. W. F. LOVE, E. CALLEN AND F. C. NIX. *Phys. Rev.,* **87,** 844–7 (*Sept.* 1, 1952).

Magnetization curves for spherical samples of a series of alloys in the solid solution range of Tl in In have been measured as a function of temperature and composition, and critical field curves have been obtained. These alloys show a fairly strong Meissner effect, and the breadth of the transition region increases for increasing Tl content. Alloys of high Tl content were found to have magnetic properties strongly sensitive to mechanical shock while in the intermediate state. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.55 : 621.391

8333. On the redundant information supplied in practical applications by the time and frequency-phase responses of a system. M. LEVY. Letter in *J. Appl. Phys.,* **23,** 801–2 (*July,* 1952).

The frequency-phase characteristics, used to predict the step impulse response of a system, often contain redundant information. Methods are given of eliminating this, and hence of simplifying working for the most important cases. Only low-pass filters are considered, since high- and band-pass filters can be reduced to this type. A. V. BREHME

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56

8334. On the group velocity, wave path and their relations to the Poynting vector of the electromagnetic field in an absorbing medium. K. FURUTSU. *J. Phys. Soc. Japan,* **7,** 458–66 (*Sept.–Oct.,* 1952).

An investigation as to whether the significant concepts of group velocity and wave path exist or not, when the Maxwell field energy is lost in a medium. It is concluded that, in a rigorous sense, they generally do not exist in an absorbing non-uniform medium, and that, when the energy loss in a medium is sufficiently small that only the first order changes in group velocity and wave path due to the energy loss need be taken into account, they may be said to exist and are concordant with those obtained when the field energy is not lost in that medium. It is thus meaningless to discuss their changes due to the energy loss in a medium. A.

538.561

8335. On a matrix and tensor form of the fundamental relations of the magneto-ionic theory. H. ARZELIÈS. *C.R. Acad. Sci.* [*Paris*] **234,** 2430–2 (*June* 16, 1952) *In French.*

538.561 : 532.51

8336. Experimental demonstration in the laboratory of the existence of magneto-hydrodynamic waves in ionized helium. W. H. BOSTICK AND M. A. LEVINE. Letter in *Phys. Rev.,* **87,** 671 (*Aug.* 15, 1952).

538.561 : 621.3.018.4 : 621.396.615.14

8337. Some limitations on the maximum frequency of coherent oscillations. R. S. ELLIOTT. *J. Appl. Phys.,* **23,** 812–17 (*Aug.,* 1952).

Electron beam oscillators are placed in one of two groups depending on whether or not they employ resonant energy-extractors. A natural upper frequency limit exists for the group which does. This limit depends chiefly on the a.c. beam current density and the noise level in the resonant structure. For practical values of these parameters, the maximum frequency is below the range of visible light. A.

538.561 : 621.385.1.029.5

8338. On Sahánek's relation for the generation of short electromagnetic waves in electron tubes. J. HABANEC. *Czechoslovak J. Phys.,* **1,** 19–23 (*No.* 1, 1952).

Sahánek's relation is proved by the application of Kleinsteuber's mathematical procedure to Sahánek's assumptions and it is shown that the disagreement only lies in a difference in assumptions. A.

538.561 : 621.392.2

8339. On the properties of lines with periodic structure. P. GUÉNARD, O. DŒHLER AND R. WARNECKE. *C.R. Acad. Sci.* [*Paris*] **235,** 32–4 (*July* 7, 1952) *In French.*

The field in a line, of periodic structure, can be

analysed in terms of a series of components of the form $e_k(x, y) \exp [(\psi + 2k\pi)/jp]$, where p is the periodic distance of the line structure, ψ the phase angle between successive periodic points and k, a positive or negative integer. These components are not true modes of the line as they do not individually satisfy the boundary conditions. The phase and group velocities of components with $k < 0$ differ in sign, and it is suggested that the form of the dispersion curves may have application in the field of microwave valves. G. D. SIMS

538.565 : 621.317.337 : 621.396.611.4

8340. Methods of measuring the properties of ionized gases at high frequencies. I. Measurements of Q. S. C. BROWN AND D. J. ROSE. *J. Appl. Phys.*, **23**, 711–18 (*July*, 1952).

Experimental methods are given for determining the Q of both high- and low-Q resonant cavities at microwave frequencies. The emphasis is placed on the practical measurements necessary in determining the properties of ionized gases in the 3- and 10-cm wavelength range. A.

538.565 : 621.317.324 : 621.396.611.4

8341. Methods of measuring the properties of ionized gases at high frequencies. II. Measurement of electric field. D. J. ROSE AND S. C. BROWN. *J. Appl. Phys.*, **23**, 1719–21 (*July*, 1952).

Experimental methods are given for determining the electric field within resonant cavities in the microwave region. Methods are discussed of calculating the electric field in both simple and complex structures used in gas discharge studies. A.

538.566 : 621.3.011

8342. Microwave circuit theory. T. SAKURAI. *J. Phys. Soc. Japan*, **7**, 185–9 (*March–April*, 1952).

The electric current I and the voltage V on the imagined surface S are defined by $IF = H^t$, $P = VI^*$ or $IF = E^t$, $P^* = VI^*$, where H^t, E^t are tangential magnetic and electric field components on S, F is a vector function depending only on the distribution of H^t and E^t on S, I is a scalar complex constant depending only on the total strength of H^t or E^t, P is the apparent power flowing through S, and * expresses the conjugate value of the quantity. It is proved that $\partial Z/\partial\lambda$ is positive and $||\partial Z_{kh}/\partial\lambda||$ is the positive definite form in the reactive case, where $\lambda = j\omega$, Z and Z_{kh} are impedance and impedance matrix element respectively; and $Q = (1/r)\sqrt{(L/C)}$ in the resonant case, where r, L, C are resistance, inductance and capacity. A.

538.566

8343. Theory of diffraction at a cylinder with consideration of the surface wave. W. FRANZ AND K. DEPPERMANN. *Ann. Phys.* [*Lpz.*] **10**, 361–73 (*No.* 6–7, 1952) *In German.*

The peculiar maxima and minima observed in the diffraction of cm waves by metal cylinders are explained as due to interference of the wave, reflected geometrically, with a wave propagating round the surface of the cylinder and whose amplitude decreases exponentially outwards. Numerical values are worked out by means of Maue's integral equation [Abstr. 1677 (1950)] and are in agreement with experimental results. L. PINCHERLE

538.566

8344. On the diffraction of plane cylindrical e.m. waves. N. V. ZERNOV. *Zh. Tekh. Fiz.*, **21**, 1066–75 (*No.* 9, 1951) *In Russian.*

The author states that while the diffraction problems have been already solved satisfactorily for the case where the orifice is small in comparison with the wavelength, a more general case of the orifice of arbitrary dimensions requires further investigation. He offers a method of solution of this problem in respect of a type of axially symmetrical waves which he classes as "plane cylindrical" waves and which had been previously referred to as "cylindrical waves with $n = 0$" [N. S. Japolsky, *Phil. Mag.*, **19**, 934–58 (*May*, 1935)], in which either the electric lines of force (in the case of the "electro-polarized," or "transverse electric," or "H-waves") or the magnetic lines of force (in the case of the "magneto-polarized," or "transverse magnetic" or "E-waves") are circles, co-axial with the axis of symmetry. These waves are likely to be formed inside cylindrical waveguides, as well as outside them, after passing through a circular or an annular co-axial orifice. He states that he applies to his analysis a method previously used by A. G. Vlasov for the problems of elasticity and electrostatics. The cases of the "H-waves" and the "E-waves" are considered separately, although the procedure used and the results obtained are analogous in both cases. From the very beginning, the Maxwell equations are transformed into a form in which all three components of the field, which are not equal to zero, are expressed as derivatives of the scalar potential satisfying the wave equation. The expressions for this scalar potential are sought separately for three zones:—(I) inside the waveguide; (II) in the cylindrical space formed by an imaginary continuation of the inner surface of the guide outside it; and (III) in the space outside (II) and in front of the guide and of the infinite plane conducting screen, perpendicular to the axis of the guide, with a hole through which (I) and (II) communicate. Four continuity equations of the field at the plane boundary between (I) and (II) and at the cylindrical boundary between (II) and (III) are then written in terms of the scalar potential. In zone (I) the expression for the scalar potential is sought in the form of a sum of three terms which the reader may interpret as an incident wave train, a wave train reflected from the boundary, and a set of infinite number of pulsations uniformly distributed along the axis. In zone II the expression is sought in the form of an infinite Fourier series of travelling waves and a Fourier integral of standing waves. In zone III the expression is sought in the form of Fourier integral of standing waves. As is appropriate for the waves of this kind, the dependence upon the radial co-ordinate is expressed, for zones I and II, in the form of Bessel functions of the first kind of the order "1" with a root on the boundary, while for zone III it is expressed in the form of Hankel function of order "1", in order to satisfy the Sommerfeld radiation conditions at the infinity. These expressions are then introduced into the continuity equations. In this way the problem is reduced to the solution of integral equations of second kind. The solution of these integral equations is, in its turn, reduced to the solution of an infinite number

of simultaneous algebraic equations, which theoretically should involve a constructing and calculating of infinite matrices. In actual practice, however, a satisfactory approximation can be obtained by using a successive approximation ("reduction") method and limiting the actual work to the solution of two equations, as the magnitude of the members of the matrices is quickly diminishing. The author considers that this method can be used for many other boundary problems of electrodynamics.

N. S. JAPOLSKY

538.566

8345. Space problem of the diffraction of monochromatic e.m. waves. D. Z. AVAZASHVILI. *Dokl. Akad. Nauk SSSR*, **82**, 29–32 (*No.* 1, 1952) *In Russian.*

In his previous paper [*Trudy Tbilisskovo Matematicheskovo Instituta*, **8**, 109 (1940)] the author proved the uniqueness of the solution of the diffraction problem, i.e., the problem of the distribution of the e.m. field in space for a given distribution of the field at a boundary surface. The purpose of the present paper is to establish the conditions for the existence of this solution [Abstr. 4717 (1952)]. The author states that the complete solution of the plane problem has been obtained by V. D. Kupriadze [*Trudy Tbilisskovo Mat. Inst.*, **2**, 143 (1937); *Compositio Math.*, **6**, 228 (1938)]. When Kupriadze tried to apply his method to the space problem, he did not offer a complete investigation of the integral equations to the solutions of which he reduced his problem. Results similar to Kupriadze's were earlier obtained by Sterling [*Compositio Math.*, **3**, 254 (1936)]. The author states the mathematical problem of diffraction as follows:—To find a distribution in the space inside and outside a closed surface of two vectors, $\boldsymbol{B}$ and $\boldsymbol{H}$, single harmonic in time, and obeying Maxwell's equations, and satisfying the continuity conditions of the tangential component at the boundary, and also satisfying the Sommerfeld radiation conditions at infinity for both these vectors, at given conductivities, σ_1 and σ_2, dielectric constants, ε_1 and ε_2, and permeabilities, μ_1 and μ_2, for the media inside and outside the boundary surface, resp. Then he expresses, in the usual way, vectors $\boldsymbol{E}$ and $\boldsymbol{H}$ in terms of vector potential $\boldsymbol{F}$ and scalar potential ϕ ($\boldsymbol{H} = 1/\mu \operatorname{curl} \boldsymbol{F}$; $\boldsymbol{E} = \operatorname{grad} \phi + i\omega/c\boldsymbol{F}$). He also assumes that $\boldsymbol{F}$ can be defined within the accuracy of the gradient of an arbitrary scalar function, satisfying certain conditions, the significance of which he does not state explicitly, but which apparently are chosen with a view to enable him to reformulate the problem in the desired form. In this way he reduces his problem to two boundary problems, one for the vector $\boldsymbol{F}$ and the other for the scalar ϕ. The conditions for these problems can then be formulated as (1) the validity of the wave equation for $\boldsymbol{F}$ and ϕ in both media; (2) the continuity of curl $\boldsymbol{F}$, as well as of the tangential component of $\boldsymbol{F}$, at the boundary surface; and (3) the possibility of expressing within the accuracy of $\exp(ik_2 r)\, 0\{r^{-1}\}$, (where r is the distance from the boundary and k_2 is a constant which may be either real or complex with a positive imaginary part), the sought vector and scalar, $\boldsymbol{F}$ and ϕ, in terms of a known vector $\boldsymbol{G}$ and a known scalar ψ, resp., both satisfying the wave equation in the space outside the boundary. It is further stated by the author that the solutions of the differential equations expressing these conditions can be found by solving two Fredholm integral equations, which are written down without explaining in any detail how they were obtained. Further reasoning aimed at the proving of the theorem of existence, is based on the above mentioned papers and books by V. D. Kupriadze and the author, but it is not set out explicitly in the present paper.

N. S. JAPOLSKY

538.566 : 621.396.9 : 621.396.671

8346. Electromagnetic back-scattering from cylindrical wires. C. T. TAI. *J. Appl. Phys.*, **23**, 906–16 (*Aug.*, 1952).

The problem of electromagnetic back-scattering or radar response from cylindrical wires has been investigated using a variational method. The relation between this method and the induced e.m.f. method is discussed. To demonstrate the flexibility of the variational calculation different trial functions have been used to determine the numerical values of the back-scattering cross-section for the case of broadside incidence. The boundary condition regarding the currents at the ends of the wire is also carefully examined.

A.

538.566

8347. On the theory of wave propagation in an electron beam. L. N. LOSHAKOV. *Zh. Tekh. Fiz.*, **22**, 193–202 (*No.* 2, 1952) *In Russian.*

In order to simplify the problem, an assumption is made that the electrons can move only in one direction, though without any other restrictions. As a model for a medium corresponding to this kind of motion, a waveguide is taken, filled with a dielectric provided with very many narrow longitudinal channels. The analysis begins from the statement of the wave equation in a dielectric with the restrictions stated, with a dielectric constant ε, and permeability μ, in which the electrons move only in the longitudinal direction z, with velocities u, forming convection currents of densities I. All variable quantities are supposed to have an angular frequency ω. The wave equation is written in respect to the longitudinal component of the electric field intensity E_z in two forms:—in Cartesian co-ordinates, for a waveguide of rectilinear section, and in cylindrical co-ordinates, for a waveguide of circular section. Apart from their harmonic components, the currents I and the velocities u also have time constant components, I_0 and u_0 resp. At the beginning the frequency, ω, is assumed, in a general case, to be complex, but later the analysis is restricted to the case where it is real. From these assumptions it is possible, on the basis of elementary formulae for the motion of electrons in an electric field parallel to this motion, to express the variable components of the currents in terms of the constant components of electron velocities u_0 and electric field E_z. As usual, for the waveguide of rectangular section, the solutions of the equations are sought in the form of waves travelling in direction z, but standing in the transverse directions, with whole number of waves in both transverse directions. In the case of a waveguide with circular cross-section, the waves are also assumed to travel in the longitudinal direction z, but to be standing in the azimuthal

direction; i.e. forming a set of two cylindrical waves rotating in opposite senses [Japolsky, *Phil. Mag.*, **19**, 934–58 (*May*, 1935)] which must, in the radial direction, follow the Bessel functions of the first kind of the order equal to the azimuthal waves. These solutions are generally used in the case of ordinary waveguides, but they must be regarded as tentative in the case of an artificial dielectric discussed in this article. By introducing these tentative solutions in the above mentioned wave equations, adapted to the present case, it is found that the conditions in which these equations are satisfied are determined by the solutions of algebraic equations of fourth degree, which by a suitable change of variables can be made equally applicable to a circular and to rectangular waveguides. The physical interpretations of the solutions, which are illustrated by charts, show that the currents may be weakened or intensified with the increase of the distance from the entrance of the waves, depending upon the ratio between the phase velocity of the waves and the initial velocity of the electrons. Of some special interest is the case where the phase velocity is much higher than the electron velocity, which corresponds to the case considered by Ramo (1939), who resolved the waves into two components:—the "field waves" and the "space charge waves." The case where the phase velocity is equal to the average electron velocity is specially considered. N. S. JAPOLSKY

538.566 : 621.392.26

8348. On the transient phenomena in the wave guide. M. NAMIKI AND K. HORIUCHI. *J. Phys. Soc. Japan*, **7**, 190–3 (*March–April*, 1952).

Investigates the deformation of waves travelling in a nonloss waveguide owing to the dependence of the phase velocity on the frequency. The general formula was applied to the case in which a sinusoidally oscillating source is impressed at the time $t = 0$. In this illustrative example, the wave front and the signal front travel in the waveguide with the velocities $(1/\sqrt{\mu\varepsilon})$ and $(1/\sqrt{\mu\varepsilon}\, s_p)$, respectively $[s_p = \rho/\sqrt{(\rho^2-1)}$, ρ = ratio of the excitation to the cut-off frequency]. The initial oscillations before the signal front have small amplitudes, while the amplitudes of the signal waves are of the order of magnitude of the steady wave. After arrival of the signal the transient disturbances decrease with increasing time and the steady wave only remains. Oscillations with a finite time interval are also considered. A.

538.566 : 621.392.26

8349. Symmetrically placed inductive posts in rectangular wave guide. H. GRUENBERG. *Canad. J. Phys.*, **30**, 211–17 (*May*, 1952).

A theoretical expression is derived for the susceptance of two symmetrically placed inductive posts in rectangular waveguide. Universal curves are drawn up that are valid for all rectangular guides in their normal operating range, for different post diameters and offsets. Reasonable agreement has been obtained with experiments at 10·7, 4·74 and 3·20 cm wavelengths. A.

538.566.2 : 519.2 : 621.396.11

8350. Fundamentals of probability theory. G. BANGEN AND H. W. FASTERT. *Tech. Hausmitt. NordwDtsch. Rdfunks. Special Number "Unterlagen für UKW-Netzplanungen"* [*Bases for planning of u.s.w. networks*] 35–44 (1952) *In German.*

An outline of the principal features of the calculus of probability, with particular reference to its application to the phenomena of the propagation of electromagnetic waves. Section A considers the case of a one-dimensional random variable, with explanation of the characteristics of normal distribution and extension to random variables dependent on two parameters. Section B discusses the case of two-dimensional random variables and explains the concept of correlation and also some special formulae previously occurring in the theory presented. See Abstr. 8351–2 (1952). A. WILKINSON (R)

538.566.2 : 519.2 : 621.396.61.029.62 : 621.396.8

8351. Simplified method for determining service probability and its application to the planning of u.s.w. networks. R. GRESSMANN AND K. H. KALTBEITZER. *Tech. Hausmitt. NordwDtsch. Rdfunks. Special Number "Unterlagen für UKW-Netzplanungen"* [*Bases for planning of u.s.w. networks*] 3–17 (1952) *In German.*

The F.C.C. statistical treatment of field strength is outlined without going deeply into the mathematical aspects of the problem, and the question of its suitability for application to the conditions existing in Germany is critically examined. The observed (logarithmic normal) statistical field-strength distribution is explained. With the help of practical examples, application to the estimation of the service area of a transmitter is made in three stages: (*a*) with no interference; (*b*) with a single interfering signal; (*c*) with several interfering signals; use is made of only the simplest possible mathematics. A map shows the estimated television service area for the various transmitters in Western Germany. See Abstr. 8350, 8352 (1952). A. WILKINSON (R)

538.566.2 : 519.2 : 621.396.61.029.62 : 621.396.8

8352. Method for determining the service probability in the field of a transmitter affected by any number of interfering transmitters. J. GROSSKOPF. *Tech. Hausmitt. NordwDtsch. Rdfunks. Special Number "Unterlagen für UKW-Netzplanungen"* [*Bases for planning of u.s.w. networks*] 18–34 (1952) *In German.*

A detailed explanation of the statistical method of service-area estimation, taking account of interfering fields, described in the Report of the Ad Hoc Committee, F.C.C., Washington, D.C. Since this report omits the greater part of the mathematical basis for the numerous formulae given, sufficient mathematics is here included to make the formulae intelligible. See Abstr. 8350–1 (1952). A. WILKINSON (R)

538.566.2 : 536.7 : 535.1

On Helmholtz's principle of optical reversibility. *See Abstr.* 8032

538.566.2 : 621.396.11

8353. Anomalous multiple reflections from the ionosphere in the absence of magneto-ionic interference. S. S. BANERJEE, R. R. MEHROTRA AND V. D. RAJAN. Letter in *Sci. Cult.*, **17**, 439–40 (*April*, 1952).

Short note with figure showing that the anomalous amplitudes of successive orders of reflected pulses observed at vertical incidence continue in the absence of magneto-ionic interference. Observations support

the theory that the anomalies are associated with undulations in the lower fringe of the ionosphere.

G. M. BROWN

538.566.2 : 621.396.11 : 621.396.812.3

8354. Fading of radio signal on medium wave from oscillatory motion of lower ionosphere. T. P. SINGH. Letter in *Sci. Cult.*, **17**, 472–3 (*May*, 1952).

Regular periodic fading of signals on 338·6 m and 434·8 m observed at Delhi are explained in terms of variations of the instantaneous electron density at the reflecting point caused by S.H. oscillations of the lower ionosphere. The effect is most pronounced as night advances.

G. M. BROWN

538.566.2 : 621.396.671 : 621.396.11

8355. The dipole field in an inhomogeneous atmosphere. B. FRIEDMAN. *New York Univ. (Wash. Sq. Coll.) Math. Res. Group, Res. Rep. No. EM-28*, 56 *pp.* (1951).

Presents a mathematical theory of radiowave propagation above a spherical earth for stratified media with an arbitrary radial variation of the refractive index. The theory corresponding to a radial magnetic Hertzian dipole used as the source of radiation is worked out in detail; appropriate changes to be made for the case of an electric dipole are indicated. The transformation used by Watson is extended to the general case. It is shown that the Hertzian potential for a non-uniform atmosphere can be obtained from that for a constant atmosphere by making suitable substitutions, which until now was known for certain special refractive-index variations only. Some mathematical questions concerning the continuous spectrum are examined in detail.

MATHEMATICAL REVIEWS

538.566.3 : 621.396.11

8356. Comparison of the double refraction in crystals and in the ionosphere. G. LANGE-HESSE. *Arch. elekt. Übertragung*, **6**, 149–58 (*April*, 1952) *In German.*

Anisotropy in the ionosphere is caused by the magnetic field of the earth and electromagnetic waves in the ionosphere undergo double refraction. The analogies that exist between this double refraction and that occurring in crystals are considered and non-analogies explained. The magnetic field of the earth does not play the same role as the optic axis in crystals and no direction exists in the ionosphere corresponding to this axis. However, it is shown how the refractive index of the ionosphere may be calculated by the methods used in crystal optics; the result agrees with that of Appleton [*J. Instn Elect. Engrs*, **71**, 642–50 (*Oct.*, 1932)]. Brief reference is made to observation of ionospheric double refraction. The requisite crystal optics theory is given.

H. G. JERRARD

538.566.3 : 621.396.11

8357. On the spreading of electromagnetic pulses propagating in the ionosphere. B. N. GERSHMAN. *Zh. Tekh. Fiz.*, **22**, 101–4 (*No.* 1, 1951) *In Russian.*

An incoming plane wave pulse is represented as a sinusoidal function with a variable amplitude ("quasi-monochromatic" wave). The same pulse, deformed in the course of propagation in ionized gas, can be represented in the form of a Fourier integral with a variable phase, a function of the variable frequency of the integrand. In previous publications (Ginzburg, 1942, 1949) the variable phase was developed in Taylor's series up to the second order. In the present paper the author considers the results of increasing the degree of approximation by taking into account the terms of the third order. To facilitate the calculations, he converts the Fourier integral into an integral of a product of an Airey function and a sum of two Fresnel integrals, by using a general relationship between the product of two functions and their Fourier transforms. He shows that the new degree of approximation discloses an asymmetry in the spreading of the pulse forward and backward, which could not be seen from the previous approximations. He evaluates the transformed Fourier integral, thus finding the numerical differences between the "forerunner" and the "rear" of the signal and the degree of accuracy attainable by this method. According to his estimations, the method is still accurate enough for signals of 10^{-5} sec duration (shorter than usual for ionosphere investigation), but it is not applicable for signals of the order of 10^{-6} sec or less.

N. S. JAPOLSKY

MAGNETIC EFFECTS 538.6

538.632

8358. Carriers of electricity in metals exhibiting positive Hall effects. S. BROWN AND S. J. BARNETT. *Phys. Rev.*, **87**, 601–7 (*Aug.* 15, 1952).

The momentum associated with the electric current in metals has been measured for the first time under conditions in which they are known to have positive Hall coefficients. Such metals are of particular interest because their positive (anomalous) coefficients suggest the possibility of positive electric carriers. A coil of the wire under investigation was supported with its axis vertical as a torsional pendulum. The extremely small deflections resulting from the inertial effect of successive reversals of current were measured by a resonance method. A phototube and oscilloscope method for measuring both the amplitude and the phase of the small deflections is described. In more than 100 determinations on Mo and Zn the sign of the charge-to-mass ratio was always found to be negative. For both Mo and Zn the mean value of e/m was found to be within 3% of the value for free electrons in slow motion. One set of determinations for Mo was made at liquid air temperatures. The direct mechanical method used to measure e/m is independent of any particular theory of metallic conduction. The results thus discriminate against theories for which current and momentum can have the same direction. In particular, the results rule out the possibility that positive Hall effects may be explained by positive carriers.

A.

538.639

8359. The additional resistance of ferromagnetic metals. A. G. SAMOĬLOVICH AND V. A. YAKOVLEV. *Zh. Eksper. Teor. Fiz.*, **22**, 350–5 (*No.* 3, 1952) *In Russian.*

A mathematical investigation of the effect of

spontaneous magnetization of a ferromagnetic crystal on its electrical resistivity, on the basis of spinor–orbital interaction of the "outer" *s*-electrons and "inner" *d*-electrons. The order of magnitude and temperature dependence ($\sim T^2$) of the additional resistivity, for low temperatures, are estimated.

F. QUELON

538.639

8360. The magneto-resistance of ferromagnetic Al–Si–Fe alloys. R. PARKER. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 616–20 (*Aug.*, 1952).

By extending the treatment in an earlier paper [Abstr. 6371 (1951)] an equation is derived for the saturation magneto-resistance of some mixed ferromagnetic alloys as a function of composition and temperature. Results calculated from this equation are in good agreement with experiment for the Al–Si–Fe alloy system. A.

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

8361. Some investigations in the field of the theory of solids. II. Linear chain of different atoms. Binary systems. T. A. HOFFMANN. *Acta Phys. Hungarica*, **1**, 175–95 (*No.* 2, 1951).

For Pt I, see Abstr. 7143 (1951). See also Abstr. 4907 (1949). In this paper a linear chain is treated which is built up of different atoms of two kinds. A general treatment is given for the case of binary systems regardless of the number of the various atoms. Formulae are given for the calculations in the case of an ordered linear alloy of this binary type. Closer investigations have been made for the types A-B-A-B, A-A-B, A-A-B-B and A-A-A-B with and without neglected overlap integrals. A.

539.11

8362. Recent advances in the electron theory of metals. N. F. MOTT. *Progress in metal physics*, *vol.* 3, *pp.* 76–114 (1952) [See Abstr. 8617 (1952)].

A review. A development of the author's earlier discussion of the basis of the theory of metals [Abstr. 4908 (1949)] is followed by a consideration of various physical properties of metals and alloys: (i) magnetic properties; (ii) electronic specific heat; (iii) cohesive energy; (iv) elastic constants. The work of Friedel [Abstr. 3758 (1952)] on the distribution of electrons in alloys is reviewed and recent advances in the application of soft X-ray spectroscopy are discussed. 115 references. E. P. WOHLFARTH

539.11

8363. A new calculation of some properties of metallic beryllium. B. DONOVAN. *Phil. Mag.*, **43**, 868–74 (*Aug.*, 1952).

A quantum mechanical calculation of the lattice constant, compressibility, cohesive energy and work function of metallic Be is carried out, using an extension of the cellular method of Wigner and Seitz. Wave functions and energies corresponding to the lowest electronic state in the metal are obtained by numerical integration of the Schrödinger equation, and the ion-core field used is of the Hartree type. The Fermi energy is evaluated by determining the effective electronic mass according to the method devised by Bardeen. Free-electron values are used for the exchange and correlation energies; it is pointed out that the corrections to these two terms may tend to cancel each other. The energy of the valence electrons in the free atom is obtained from the calculations of Hartree, together with the correlation energy. With the exception of the work function, the final results agree very satisfactorily with experiment and compare favourably with the values obtained by more elaborate methods. A.

539.11

8364. Effect of radiation on elastic constants. F. R. N. NABARRO. Letter in *Phys. Rev.*, **87**, 665 (*Aug.* 15, 1952).

A criticism of Dienes' calculations [Abstr. 5216 (1952)] and a suggestion, based on classical elasticity theory, that the difference between the effects of small numbers of interstitial atoms and of vacancies on the elastic constants of Cu is less than as found by Dienes. A. D. LE CLAIRE

539.11

8365. Effect of radiation on elastic constants. G. J. DIENES. Letter in *Phys. Rev.*, **87**, 666 (*Aug.* 15, 1952).

While agreeing in principle with Nabarro's objections (preceding abstract) the author criticizes his calculations and maintains that classical elasticity theory does not lead to conclusions substantially differing from those previously expressed.

A. D. LE CLAIRE

539.11

8366. A soluble problem in energy bands. J. C. SLATER. *Phys. Rev.*, **87**, 807–35 (*Sept.* 1, 1952).

The problem of an electron moving in a periodic simple cubic potential of the form $\cos x + \cos y + \cos z$ is investigated, with particular attention to the nature of the wave functions, Wannier functions, degeneracy of overlapping bands, etc. It is well known that this problem is separable, leading to Mathieu's equation for the functions of x, y, and z. This equation can be solved, making use of the Fourier expansion of the wave function (the momentum eigenfunction). Solutions are set up, for a number of interatomic distances. The momentum eigenfunctions are similar to Hermite functions for the tightly-bound levels, but very different for free-electron-like levels. Those for the levels near the top of the potential barrier, corresponding to the valence and conduction bands of a real crystal, are very complicated; their properties are illustrated by means of a test of the completeness relation for orthogonal functions. It is proved that the Wannier function is the Fourier transform of the momentum eigenfunction, and special cases are discussed. The effect of various perturbations on the one-dimensional problem is considered. It is shown that the usual

assumption made in band theory, connecting the width of the gap introduced by a perturbation with the matrix component of the perturbative potential, is not generally justified. The case of a perturbation of double periodicity is taken up, and it is shown that this results in a spreading out of the Wannier function, which sometimes has large contributions on many atoms. In the two- and three-dimensional cases, the interesting feature is the degeneracy between overlapping bands, for example between the different components of a p or a d band. These are discussed in detail. For the unperturbed Mathieu case, the energy surfaces cut without interaction, but almost any reasonable perturbation will cause them to interact, resulting in perturbed bands of great complication, which will not cut each other, though they may adhere at certain points of crystal symmetry, as can also be proved by group theory. The Wannier functions in these cases become combinations of the Wannier functions of the unperturbed problem, located on many different atoms, and possessing the rotational symmetry of the crystal, which the unperturbed Wannier functions do not have. The type of perturbation is also taken up which would convert the simple cubic potential of the unperturbed problem into a face-centred or body-centred structure. A.

MOLECULAR STRUCTURE 539.13

539.132

8367. Vibrational and centrifugal effects on nuclear interactions and rotational moments in molecules. N. F. Ramsey. *Phys. Rev.*, **87**, 1075–9 (*Sept.* 15, 1952).

The effects of zero point vibration and centrifugal stretching of molecules upon the spin-spin magnetic interaction, the spin-rotational magnetic interaction, the molecular rotational magnetic moment, the magnetic shielding of the nucleus and the molecular diamagnetic susceptibility of the molecule are discussed. Expressions for these quantities with vibrational and centrifugal effects included are given in detail for diatomic molecules and numerical calculations for the cases of H_2 and D_2. It is shown that from measurements of the rotational magnetic moments of both H_2 and D_2 or of H_2 in two different rotational states, one can calculate the variation with internuclear separation of the high frequency terms of the molecular diamagnetic susceptibility. Measurements on the spin-rotational magnetic interactions in both H_2 and D_2 provide information on the variation of this interaction with internuclear spacing and thereby supply important corrections that are needed in calculating the nuclear magnetic shielding from the spin rotational magnetic interaction and in measuring the ratio of the proton magnetic moment to that of the deuteron. These calculations also supply a correction to the spin-spin magnetic interaction that must be used in determining the deuteron quadrupole moment from experiments with D_2. A.

539.132

8368. Study of the influence of various solvents on the fundamental valence vibration of the carbonyl group of ketones. E. Gray and A. Hidalgo. *C.R. Acad. Sci.* [*Paris*] **235**, 152–4 (*July* 16, 1952) *In French.*

The wave number of the $\sim 1700\ cm^{-1}$ carbonyl band of ketones differs slightly for infrared and Raman spectra. This is due to the antiparallel coupling between two carbonyl groups. When ketones are dissolved in nonpolar liquids (carbon tetrachloride or cyclohexane), the absorption wavenumber of this fundamental vibration increases with higher dilution. When dissolved in phenol or other solvents containing OH groups, the frequency decreases with higher dilution. These phenomena can be explained by the assumption of the coupling mentioned. The absorption intensity is higher in cyclohexane than in carbon tetrachloride: this may be due to the difference in the molecular volumes of the solvents. A. J. TAYLOR

539.132

8369. A method of solving systems of similar linear equations in the calculation of vibration of polyatomic molecules. P. G. Maslov. *Zh. Eksper. Teor. Fiz.*, **22**, 276–83 (*No.* 3, 1952) *In Russian.*

The method allows a determination not only of the eigenvalues and eigenvectors of $(G - A)r = 0$, but also of their dependence on certain parameters; the usual cycle of iterations for an additional vector is avoided. An application is given to the Ag frequency determination of C_2H_6. J. JACOBS

539.132

8370. Electronic states of C_2-molecule. II. Effect of 2s-shells. G. Araki and W. Watari. *Progr. Theor. Phys.*, **6**, 945–60 (*Nov.–Dec.*, 1951).

For Pt I, see Abstr. 8088 (1951). Adiabatic potentials corresponding to 62 electronic states, arising from various configurations of the C_2-molecule which consists of two carbon atoms with two $2p$-electrons each, are calculated taking into account the effect of $2s$-shells. The complete adiabatic Hamiltonian of eight electrons, but not a so-called interaction operator, is used, and direct, exchange, higher permutation, and overlapping integrals are all taken into account. The same effective charge χ is assumed for $2s$, $2p\sigma$, and two $2p\pi$ orbitals, and the minimum electronic energy is obtained by varying χ for each nuclear distance. It is found that $2s$-shells repel $2p\sigma$ electrons and attract $2p\pi$-electrons. Thus the $(s^2\sigma^2, s^2\sigma^2)^1\Sigma_g^+$ state, which was found to be attractive and deepest when the effect of $2s$-shells was neglected in Pt I, becomes higher and repulsive. The results of the present calculation are that the deepest state is $(s^2\sigma\pi, {}^2\sigma\pi)^1\Delta_g$ and that $(s^2\sigma\pi, {}^2\sigma\omega)^1\Sigma_g^+$ and $(s^2\sigma\pi, s^2\pi\omega)^1\Pi_u$ are next and third respectively. A.

539.132

8371. Electronic states of C_2-molecule. III. Numerical values and reduction formulas of integrals. G. Araki and W. Watari. *Progr. Theor. Phys.*, **6**, 961–79 (*Nov.–Dec.*, 1951).

In Pts I and II the numerical evaluation of various integrals were carried out by making use of Kotani, Amemiya, and Simose's table (1938, 1940). To make use of the table for our calculation some supplementary formulae and tables for the integrals had to be prepared. Some of these are given here because useful for other calculations. A.

539.132

8372. Properties of the π-electron distribution in conjugated systems. H. H. GREENWOOD. Letter in *J. Chem. Phys.*, **20**, 1333 (*Aug.*, 1952).

Relations are derived for the dependence of the variations in charge densities, free valences and bond-orders in conjugated molecules upon variations in Coulomb integrals, which may be of interest in the discussion of chemical reactivity. The series, in which these relations are expressed, seem to converge for Coulomb integral changes $\leqslant 1$. A. J. TAYLOR

539.132

8373. Quantum theory of the N_2-molecule. II. Treatment of the N_2-molecule as 10-electron problem. H.-J. KOPINECK. *Z. Naturforsch.*, **7a**, 314–24 (*May*, 1952) *In German.*

For Pt I, see Abstr. 5219 (1952). The $^1\Sigma_g^+$ ground state is examined using localized valences and for comparison equivalent molecular orbitals. Hybridization of $2s$ and $2p_\sigma$ functions is allowed in both cases with the parameter $\lambda = 0{\cdot}18$, found with the Ritz method. The calculated values are dissociation energy $D = 9{\cdot}261$ eV (equ. functions 9·099), internuclear distance $R = 1{\cdot}108$ Å (1·109). Slater's nodeless $2s$ functions are used and cause the high Z value ($Z \simeq 5$). J. JACOBS

539.132

8374. Resonance energy. S. L. ALTMANN. *Cienc. e Invest.*, **8**, 250–8 (*June*, 1952) *In Spanish.*

A review of some aspects and applications of the concept of resonance in the theory of molecules. L. PINCHERLE

539.132

8375. The stability of semiquinones. N. S. HUSH. Letter in *J. Chem. Phys.*, **20**, 1343–4 (*Aug.*, 1952).

Variations in total energy change, which occur during reductions of a series of quinones, are mostly due to variations in changes of the unsaturation energy. These are evaluated quantum-mechanically (L.C.A.O. approximation). The corresponding quinonedimethanes and their ions are first discussed and the differences in Coulomb and resonance integrals between these and the quinones are considered as perturbations. It is concluded that the formation constant as well as the relative stability of semiquinones will increase with decreasing oxidation potential. A. J. TAYLOR

539.132

8376. Numerical tables of overlap integrals for 3*s*, 3*p* hybrid A.-O. Y. AOKI. *J. Phys. Soc. Japan*, **7**, 451–7 (*Sept.–Oct.*, 1952).

The numerical calculations for the overlap integrals between $3s$, $3p$ hybrid A.-O. (atomic orbitals) and $1s$, $2s$, $3s$ $3p$ hybrid A.-O. are tabulated in this paper by the use of Slater's A.-O. A.

539.133

8377. Proton magnetic resonance absorption in hydrogen perchlorate monohydrate and the structure of the oxonium ion. I. Y. KAKIUCHI, H. SHONO, H. KOMATSU AND K. KIGOSHI. *J. Phys. Soc. Japan*, **7**, 102–8 (*Jan.–Feb.*, 1952).

The shape of proton magnetic resonance absorption line in hydrogen perchlorate monohydrate was observed. The line was found to be simple and narrow at the room temperature, and to show the complicated structure corresponding to "three proton system" at the temperature below 150°K. These results were interpreted as follows: the crystal is composed of the oxonium ion OH_3^+ and the perchlorate ion ClO_4^-, the orientation of the oxionium ion being well fixed at lower temperatures. At high temperatures, above the transition point at 150°K, however, the oxonium ion begins to rotate around the centre of mass, resulting in the narrowing of the absorption line. H–H distance in the oxonium ion was estimated to be 1·6–1·7 Å, in good accord with the expected value. A.

539.133

8378. Proton magnetic resonance absorption in hydrogen perchlorate monohydrate and the structure of the oxonium ion. II. Y. KAKIUCHI AND H. KOMATSU. *J. Phys. Soc. Japan*, **7**, 380–2 (*July–Aug.*, 1952).

From the more detailed analysis of the proton magnetic resonance absorption in hydrogen perchlorate monohydrate described in Pt I, the pyramidal structure of the oxonium ion is again confirmed. A.

539.133

8379. Influence of chain length on the symmetry of conjugated molecules. J. D. DUNITZ AND L. E. ORGEL. Letter in *J. Chem. Phys.*, **20**, 1328 (*Aug.*, 1952).

Simple molecular orbital calculations for acetylenes and the $CH_2(C)_nCH_2$ series were made. Where several molecular symmetries are possible, the configurations are determined by molecular energies for short chains, by intermolecular forces for long ones. J. JACOBS

539.133 : 541.64

8380. Distribution of segments in a coiling polymer molecule. P. DEBYE AND F. BUECHE. Letter in *J. Chem. Phys.*, **20**, 1337–8 (*Aug.*, 1952).

It is usually assumed that the distribution of segments about the centre of mass of a coiling polymer molecule is Gaussian. Here the true distribution is considered: a nearly exact relation is derived for the probability that any segment is at a certain distance from the centre of mass. The distribution curve of the segments is found by graphical integration and compared with the Gaussian distribution. Discrepancies are few, but the Gaussian curve underestimates the extension of molecules in space, which may be noticeable in calculations of concentration dependence of viscosity, thermodynamic interactions in good solvents, etc. A. J. TAYLOR

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

8381. A new statistical theory of atomic nuclei. P. ROMÀN. *Acta Phys. Hungarica*, **1**, 107–14 (*No.* 2, 1951).

The internucleonic field of force is assumed to be a static, central, scalar meson field. The nucleons are imagined to move statistically distributed in this field. After getting an approximate solution of the potential equation, the binding energy of atomic

nuclei can be calculated. The energy expression thus obtained also automatically gives the surface-tension of the nuclei. The numerical results, taking into account the Coulomb energy too, agree surprisingly well with experiment. A.

539.152.1

8382. The lowest excitation level of Hg^{196}. P. STAEHELIN. Letter in *Phys. Rev.*, **87**, 374–5 (*July* 15, 1952).

By means of an electron-electron-coincidence spectrometer, this was found at 426 keV, while no level was found at 175 keV, as previously reported [Abstr. 3420 (1949)]. The new value fits well with those of other even-even nuclei. L. PINCHERLE

539.152.1

8383. Atomic beam resonance method for excited states. I. I. RABI. Letter in *Phys. Rev.*, **87**, 379 (*July* 15, 1952).

It is shown how, by illumination of the region of the "C" field with radiation of the principal series of the atoms under consideration, the author's original method can be extended to excited states and become applicable to a wide field of investigations.

L. PINCHERLE

539.152.1

8384. An experimental test of the shell model. W. C. PARKINSON, E. H. BEACH AND J. S. KING. Letter in *Phys. Rev.*, **87**, 387–8 (*July* 15, 1952).

The angular distribution of the protons from the reaction $P^{31}(d, p)P^{32}$ was found to agree with Butler's theoretical curve for $l = 2$ (l = angular momentum of captured particle in its final state). The shell model predicts in fact this value of l. L. PINCHERLE

539.152.1

8385. Evidence for nuclear shells from atomic mass measurements. H. E. DUCKWORTH. Letter in *Nature* [*Lond.*] **170**, 158–9 (*July* 26, 1952).

The plot of mass-spectroscopically determined binding energies per nucleon of some 115 stable nuclides with $Z > 21$ shows kinks at $Z = 28$, 50, 82 and $N = 50$, 82, 126. W. J. SWIATECKI

539.152.1

8386. The structure of lithium 6. A. J. M. HITCHCOCK. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 661–2 (*Aug.*, 1952).

The energies of the lowest states of Li^6 have been calculated from the standpoint of the shell model, using recent data for the proton-neutron forces. It is concluded that it is necessary to take into account the tensor force in discussing the lowest states of this and other odd-odd nuclei. A.

539.152.1

8387. The influence of charge independence of nuclear forces on electromagnetic transitions. L. A. RADICATI. Letter in *Phys. Rev.*, **87**, 521 (*Aug.* 1, 1952).

When total isotopic spin T is a good quantum number, e.m. transition between states is forbidden unless $\Delta T = 0, \pm 1$; further, $T = 0 \rightarrow T = 0$ is forbidden for electric dipole radiation. R. H. DALITZ

539.152.1

8388. Nuclear magnetic resonance lines of antimony in antimony hexafluoride ion. S. S. DHARMATTI AND H. E. WEAVER, JR. Letter in *Phys. Rev.*, **87**, 675 (*Aug.* 15, 1952).

The data of Proctor and Yu [Abstr. 2924 (1951)] have been re-examined with an improved spectrometer. Seven lines are clearly seen. Their number and relative intensity are in agreement with the coupling mechanism suggested by Gutowsky and McCall [see Abstr. 6066 (1951)]. L. PINCHERLE

539.152.1

8389. The spinning nucleus in a magnetic field: a source of classroom problems. W. J. ARCHIBALD. *Amer. J. Phys.*, **20**, 368–73 (*Sept.*, 1952).

The object of this paper is to call to the attention of those teaching quantum mechanics several of the problems arising from the behaviour of nuclei possessing a magnetic moment in an external magnetic field. These problems are simple enough to serve as student exercises. They are presented both from the classical and quantum-mechanical points of view, and this is particularly instructive in connection with the problems considered because both techniques of calculation lead to the same answers, but the results in spite of formal similarity are to be interpreted quite differently. This provides the teacher with an excellent opportunity to discuss the conceptual differences of the old and new mechanics. A.

539.152.1

8390. Intermediate coupling as encountered in some of the *p*-shell nuclei. D. R. INGLIS. *Phys. Rev.*, **87**, 915–21 (*Sept.* 15, 1952).

The manner in which a transition into intermediate coupling, between the extremes of (jj) coupling and (LS) coupling, accounts for much of the failure of the (jj) coupling shell model in the light nuclei of the p-shell is illustrated by some typical examples. The set of secular equations for the configurations p^2 and p^{-2} applying to $Li^6 + He^6$ and to $N^{14} + C^{14}$ is sufficiently simple to be worked out in detail. In the configuration p^8 which applies to $C^{12} + B^{12}$ the states are much more numerous and the equations are too complex to be solved in detail, but the solutions for the low states of interest may be treated by approximate methods, relying on some knowledge of the asymptotic behaviour in the extremes. The general features of observed energy spectra for p^{-2} and for p^8 are both compatible with the intermediate coupling scheme with the same ratio $a/K \simeq 5$ of the spin-orbit coupling parameter a to the "exchange integral" K, which separates multiplets. The criterion for whether the spectrum of the low states slightly resembles (LS) coupling, as it does in $C^{12} + B^{12}$, rather than (jj) coupling, as in $N^{14} + C^{14}$, is not just the value of a relative to K but the magnitude of a relative to the multiplet separations provided by K in (LS) coupling, which are exceptionally large among the low states of C^{12}. A.

539.152.1

8391. The binding of light nuclei in the shell model of atomic nuclei. K.-H. HÖCKER. *Z. Phys.*, **132**, 399–408 (*No.* 4, 1952) *In German.*

The influence of tensor force on the states of light nuclei is discussed, and it is shown that the tensor

force could account for the deviation of nuclear magnetic moments from the Schmidt limits. J. HUGHES

539.152.1

8392. First excited states of even-even nuclides in the heavy element region. F. ASARO AND I. PERLMAN. Letter in *Phys. Rev.*, **87**, 393–4 (*July* 15, 1952).

The distribution in energy of these as a function of the number of neutrons in the nucleus is presented graphically. The resulting distribution is briefly discussed in terms of the shell model of the nucleus. J. HUGHES

539.152.2

8393. Deviations of nuclear magnetic moments from the Schmidt lines. H. MIYAZAWA. *Progr. Theor. Phys.*, **6**, 801–14 (*Sept.–Oct.*, 1951).

The anomalous magnetic moment of a nucleon bound in a nucleus differs from the value when it is free because of the modification of virtual meson cloud around the nucleon, due to the effect of other nucleons. This modified value is calculated and shown to be about half of the value when the nucleon is free. With this value of the magnetic moment, the deviations of nuclear magnetic moments from the Schmidt lines can be explained. It is shown that this effect is equivalent to the exchange magnetic moment. A.

539.152.2

8394. On the quadrupole moments of light nuclei. H. HORIE AND S. YOSHIDA. *Progr. Theor. Phys.*, **6**, 829–36 (*Sept.–Oct.*, 1951).

The values of quadrupole moments of light nuclei, which are calculated from the usual shell model, show unsatisfactory agreement with experimental values, except for nuclei shell ± one. Consistent interpretation of quadrupole moments of light nuclei having more than one nucleon outside the closed shell, with magnetic moments, can be obtained by configuration interactions with higher nucleon configurations. A.

539.152.2

8395. The quadrupole moments of nuclei according to the spheroidal nuclear model. R. VAN WAGENINGEN AND J. DE BOER. *Physica*, **18**, 369–77 (*June–July*, 1952).

The spheroidal nuclear model of Rainwater and Feenberg and Hammack, is adapted to the strong spin-orbit coupling which is characteristic for the Mayer–Jensen nuclear model. The quadrupole moments so obtained change sign at all shells and subshells of the Mayer–Jensen shell model. The quadrupole moments calculated with the present model agree in general with the experimental values for those nuclei consisting of closed shells plus or minus one nucleon. As for some of these nuclei: K^{39}, Co^{59}, Rb^{87}, La^{139}, Pr^{141}, Sr^{87}, Zr^{91} and Gd^{157} experimental data are not yet available, only the theoretical value according to the spheroidal model is given. A discussion is also given of the quadrupole moments of nuclei with more than one nucleon or nucleon hole outside closed shells, but here the theoretical calculation is difficult as this requires the mutual interaction of the nucleons to be taken into account. A.

539.152.2

8396. The spin and magnetic moment of V^{50}. A. HITCHCOCK. Letter in *Phys. Rev.*, **87**, 664 (*Aug.* 15, 1952).

Theoretical. The energy and gyromagnetic ratio of the lowest states has been calculated with various forms of nuclear potentials. In all cases of extended range the ground state has spin 5. L. PINCHERLE

539.152.2

8397. The nuclear spin and magnetic moment of Cs^{134}. V. JACCARINO, B. BEDERSON AND H. H. STROKE. Letter in *Phys. Rev.*, **87**, 676 (*Aug.* 15, 1952).

The atomic beam magnetic resonance method was applied to the measurement of the h.f.s. interaction in the ground state. Comparison of observed frequencies with those of Cs^{133} gives $I = 4$, $\Delta\nu^{134} = 10\,465 \pm 12$ Mc/s, μ^{134} (from the Fermi–Segrè relation) $= +2{\cdot}96 \pm 0{\cdot}01$ n.m. L. PINCHERLE

539.152.2

8398. Interaction moment contributions to magnetic moments of nuclei. A. RUSSEK AND L. SPRUCH. *Phys. Rev.*, **87**, 1111–17 (*Sept.* 15, 1952).

A model of a heavy odd A nucleus is used in which the outer nucleon is in the state predicted by the Mayer scheme, and the core is in a state of zero angular momentum. It is found that the general trend of the deviations of the experimentally determined magnetic moments from the Schmidt curves is describable in terms of a linear combination of the three phenomenological interaction moment operators which can arise from a charge exchange potential in a second-order meson calculation. The final expression for the interaction moment, matched to the data, is, by and large, independent of any detailed properties of the radial functions associated with these operators, of the radial function of the outer nucleon, and, except for a dependence on the relative number of neutrons and protons in the core, of the core structure. The consequent predictions that, for given l and j, the interaction moments of heavy odd neutron nuclei should be smaller in magnitude than those of heavy odd proton nuclei and that the addition of two protons to an odd proton nucleus or of two neutrons to an odd neutron nucleus should push the moments toward the Schmidt curves are in general accord with the data. Odd-odd nuclei are also considered. A.

539.152.2

8399. Determination of the magnetic moment of an excited nucleus (Cd^{111}). H. AEPPLI, H. ALBERS-SCHÖNBERG, H. FRAUENFELDER AND P. SCHERRER. *Helv. Phys. Acta*, **24**, 339–70 (*No.* 4, 1952) *In German.*

A method for determining the g-factor of the intermediate state of a nuclear γ-γ-cascade is described. The method consists in measuring the angular correlation of the two successive γ-rays as a function of an external magnetic field perpendicular to the plane of the γ-rays. A full account is given of the apparatus and of the various corrections involved in the measurement. The method has been applied to the cascade Cd^{111}, giving a g-factor of $g = -0{\cdot}28 \pm 0{\cdot}05$ for the intermediate (247 keV) level. Because this state has a spin of 5/2, the magnetic moment becomes $\mu(247\text{ keV}) = -(0{\cdot}70 \pm 0{\cdot}12)\mu_k$. A.

539.152.2

8400. The variation of the nuclear quadrupole moments with the number of nucleons. D. PFIRSCH. *Z. Phys.*, **132**, 409–28 (*No.* 4, 1952) *In German.*

Theoretical. A one-particle Hartree model is employed. The total energy E is written as function of an eccentricity parameter γ for all possible configurations K. From $\partial E_K/\partial\gamma = 0$, the values γ_K are obtained which minimize the energy of the various configurations. The configuration of smallest energy is then chosen, and the corresponding γ determines the quadrupole moment. The dependence on the number of nucleons is determined almost entirely by the first-order perturbation of the energy values by the eccentricity parameter, and this perturbation depends in turn on spin, spin-orbit coupling and configuration. Experimental values of quadrupole moments correspond to configurations with strong spin-orbit coupling. Magic numbers are very evident. L. PINCHERLE

539.152.2 : 548.7

8401. Nuclear electric quadrupole interaction in single crystals. G. M. VOLKOFF, H. E. PETCH AND D. W. L. SMELLIE. *Canad. J. Phys.*, **30**, 270–89 (*May*, 1952).

Pound's theory of the dependence of electric quadrupole splitting of nuclear magnetic resonance absorption lines in a single crystal on the orientation of the crystal in an external magnetic field is extended to cover the case of a crystal with nonaxially symmetric electric field gradient at the site of the nuclei being investigated. It is shown that an experimental study of the angular dependence of this splitting for three independent rotations of the crystal about any three mutually perpendicular axes will yield complete information about the orientation of the principal axes and the degree of axial asymmetry of the electric field gradient tensor at the site of the nuclei, and also will give the absolute value of the quadrupole coupling constant for those nuclei. The authors' experiments on the splitting of the Li^7 absorption lines in a single crystal of $LaAl(SiO_3)_2$ (spodumene) are described and are used to illustrate the theory. The absolute value of the quadrupole coupling constant for the Li^7 nuclei in spodumene is found to be $|eQ\phi zz/h| = 75{\cdot}7 \pm 0{\cdot}5$ kc/s. The axial asymmetry parameter of the field gradient tensor at the site of the Li nuclei is found to be $\eta \equiv (\phi xx - \phi yy)/\phi zz = 0{\cdot}79 \pm 0{\cdot}01$. One of the principal axes of this tensor (the y axis corresponding to the eigenvalue of intermediate magnitude) is experimentally found to coincide with the b crystallographic axis of monoclinic spodumene as required by the known symmetry of the crystal. The other two principal axes are in the ac plane, the z axis (corresponding to the eigenvalue ϕzz of greatest magnitude) lying between the a and c axes at an angle of $48° \pm 2°$ with the c axis. A.

539.153

8402. Construction of a potential from a phase shift. R. JOST AND W. KOHN. *Phys. Rev.*, **87**, 977–92 (*Sept.* 15, 1952).

Two methods of constructing a potential, in the form of a series, from a given S phase shift are described. The convergence of one of these is analysed. Examples show that it can converge comfortably even for potentials which are so strong as to have a bound state. The ambiguity of the potential, connected with the existence of bound states, is discussed in an appendix. A.

539.153

8403. Excitation cross section for helium atoms. S. ALTSHULER. *Phys. Rev.*, **87**, 992–4 (*Sept.* 15, 1952).

The excitation scattering of electrons from He atoms is investigated in order to examine quantitatively the errors introduced by the fact that the description of the He target is only approximately known. The cross-section is calculated in Born approximation using formally equivalent matrix elements which weight the wave functions differently in space. Similar shapes for angular distribution and total cross-section v. energy curves are obtained although absolute values differ. A.

539.153

8404. Wavefunctions and oscillator strengths of Ca II ions: states, 4*s*, 4*p* and 3*d*. E. TREFFTZ AND L. BIERMANN. *Z. Astrophys.*, **30**, 275–81 (*No.* 4, 1952) *In German.*

Normal values of these parameters have been computed (allowing for polarization), and are tabulated. Results are similar to those of Hartley, the oscillator strengths being about 10% smaller, viz. $f(4s\text{–}4p) = 1{\cdot}10$; $f(3d\text{–}4p) = 0{\cdot}092$. D. R. BARBER

539.153.4

8405. Electrodynamic displacement of atomic energy levels. III. The hyperfine structure of positronium. R. KARPLUS AND A. KLEIN. *Phys. Rev.*, **87**, 848–58 (*Sept.* 1, 1952).

For Pt II, see Abstr. 5268 (1952). A functional integro-differential equation for the electron-positron Green's function is derived from a consideration of the effect of sources of the Dirac field. This equation contains an electron-positron interaction operator from which functional derivatives may be eliminated by an iteration procedure. The operator is evaluated so as to include the effects of one and two virtual quanta. It contains an interaction resulting from quantum exchange as well as one resulting from virtual annihilation of the pair. The wave functions of the electron-positron system are the solutions of the homogeneous equation related to the Green's function equation. The eigenvalues of the total energy of the system may be found by a 4-dimensional perturbation technique. The system bound by the Coulomb interaction is here treated as the unperturbed situation. Numerical values for the spin-dependent change of the energy from the Coulomb value in the ground state are finally obtained accurate to order α relative to the hyperfine structure α^2 Ry. The result for the singlet-triplet energy difference is $\Delta W_{ts} = \frac{1}{2}\alpha^2 \mathrm{Ry}_\infty[7/3 - (32/9 + 2\ln 2)\alpha/\pi] = 2{\cdot}0337 \times 10^5$ Mc/s. Theory and experiment are in agreement. A.

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.163.1

8406. Studies on radioactive bromine. E. BERNE. *Trans Chalmers Univ. Techn.* [*Gothenburg*] *No.* 124, 44 *pp.* (1952).

Br^{82} was obtained as bromide by the Szilard–

Chalmers reaction in the irradiation of $KBrO_3$ with thermal neutrons, and separated on an ion-exchange column of Ag_2O on diatomaceous earth. Back-scattering, absorption, and self-absorption (as TlBr) were studied, and the ½-life measured as 36·0 ± 0·2 hr.
A. O. STANESBY

539.163.2

8407. The radiations of Tl^{204}. L. LIDOFSKY, P. MACKLIN AND C. S. WU. Letter in *Phys. Rev.*, **87**, 391–2 (*July* 15, 1952).

The deduction, from the log *ft* value, that the transition is first-forbidden involving the B_{ij} matrix element only ($\Delta J = 2$; yes), was confirmed by a measurement of the β-spectrum with a solenoid spectrometer. The Kurie plot, using the correction factor B_{ij} was linear from the endpoint of 765 keV to ~150 keV. The presence of Hg X-rays indicated *K*-capture, and the ratio $N_K/N_{\beta-}$ was found to be 2–3%.
J. HUGHES

539.163.2

8408. Decay schemes of ^{151}Sm and ^{155}Eu. H. W. WILSON AND G. M. LEWIS. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 656–61 (*Aug.*, 1952).

Examination of the relatively long-lived isotopes produced by pile irradiation of Sm using the proportional tube spectrometer leads to the elucidation of the decay schemes of Sm^{151} and Eu^{155}. The conclusions are supported by experiments involving β–e$^-$ and β–γ coincidences, utilizing G.M. and scintillation counters.
A.

539.163.2

8409. Average charge produced by electron capture in A^{37}. J. A. MISKEL AND M. L. PERLMAN. Letter in *Phys. Rev.*, **87**, 543–4 (*Aug.* 1, 1952).

The average charge on the Cl^{37} was found to be +3·85 ± 0·2 by measuring the current in an ion chamber produced by the collection of the recoil ions from a low pressure gaseous source of A^{37}, whose absolute disintegration rate was known.
J. HUGHES

539.163.2

8410. Radiative *K*-capture in A^{37}. C. E. ANDERSON, G. W. WHEELER AND W. W. WATSON. Letter in *Phys. Rev.*, **87**, 668–9 (*Aug.* 15, 1952).

A preliminary examination of the weak continuous high-energy γ-ray spectrum accompanying *K*-capture in A^{37} indicates rough agreement with the distribution predicted by Morrison and Schiff [Abstr. 2704 (1940)].
A. O. STANESBY

539.163.2

8411. The decay of Am^{241}. J. K. BELING, J. O. NEWTON AND B. ROSE. Letter in *Phys. Rev.*, **87**, 670–1 (*Aug.* 15, 1952).

Continuation of Abstr. 6736 (1952). Further studies, including coincidence measurements, were made of the low-energy photons from the α-emitter Am^{241}; a tentative level scheme for Np^{237} is suggested.
A. O. STANESBY

539.163.2

8412. Promethium isotopes. V. KISTIAKOWSKY. *Phys. Rev.*, **87**, 859–60 (*Sept.* 1, 1952).

The half-lives and radiation characteristics of some Pm isotopes have been measured. Bombardments of isotopically enriched Nd oxide samples by 8·9–32 MeV protons and of Pr oxide samples by 15–36 MeV He ions were used to produce these nuclides. They were identified chemically and on the basis of relative yields. Nuclides studied: Pm^{141}, Pm^{142}, Pm^{143}, Pm^{144}, Pm^{146}, Pm^{149} and Pm^{150}.
A.

539.163.2

8413. The decay scheme of Ir^{192}. K. I. ROULSTON AND R. W. PRINGLE. *Phys. Rev.*, **87**, 930–2 (*Sept.* 15, 1952).

Scintillation spectrometer time-correlation studies of the Ir^{192} disintegration have yielded new information about the Pt^{192} level scheme. Gamma-rays have been observed of considerably higher energy than any reported previously.
A.

539.163.2

8414. On the decay of some odd isotopes of Pt, Au and Hg. A. DE-SHALIT, O. HUBER AND H. SCHNEIDER. *Helv. Phys. Acta*, **25**, 279–304 (*No.* 3, 1952).

The decay of the nuclides Pt^{195*}, Au^{195} and Au^{199} was investigated using a β-spectrometer in a coincidence arrangement; decay schemes and internal conversion coeffs. are given. The results are discussed in terms of the shell model; all the excited states of these 3 nuclides, and of Hg^{197} are compatible with the single-particle model of Mayer [Abstr. 6006 (1950)].
A. O. STANESBY

539.164

8415. The spins of the [energy-] levels of even-even nuclei and the theory of α-emission. S. ROSENBLUM AND M. VALADARES. *C.R. Acad. Sci.* [*Paris*] **234**, 2359–61 (*June* 9, 1952) *In French.*

In 5 cases of α-emission by even-even nuclei ($I_0^{230} \rightarrow Ra^{226}$; $Ra^{226} \rightarrow Rn^{222}$; $RdTh^{228} \rightarrow ThX^{224}$; $ThX^{224} \rightarrow Tn^{220}$ and $Po^{210} \rightarrow Pb^{206}$) the 1st excited states of the product nuclei have spin 2 (electric quadrupole transitions); this is analogous to the Goldhaber–Sunyar rule [Abstr. 8894 (1951)] for α-stable nuclides. A recalculation of the intensities of the α-particle fine structure on the Gamow theory, using these known spin values, gives results considerably lower than experiment.
A. O. STANESBY

539.164 : 539.165

8416. Internal conversion electrons from the ^{233}U decay. K. M. BISGÅRD. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 677–8 (*Aug.*, 1952).

Ilford G5 emulsions (200 μ) were impregnated with U^{233} in solution as the complex ammonium uranium citrate at pH 7, for 120 hours, and examined for α-particle (6012) and associated electron (540 ± 60, or 9·1 ± 1%) tracks. The results are consistent with 2 excited levels, at 43 and 99 keV.
A. O. STANESBY

539.165

8417. β-Ray spectrum and *ft*-values in the forbidden transitions. S. NAKAMURA, H. TAKEBE AND M. UMEZAWA. *Progr. Theor. Phys.*, **6**, 604–13 (*July–Aug.*, 1951).

It is shown that the β-spectra of Tc^{99}, Sb^{124} in the 2nd-forbidden transition, and Tm^{170} in the 1st-forbidden transition, can be explained by the tensor or vector interaction of the Fermi theory, if a suitable linear combination of matrix elements are chosen. Using the ratio of the matrix elements to provide a good fitting with the experimental spectra, *ft*-values

of each β-decay are evaluated on the corrected forbidden formula. Criticism is made with respect to the explanation of the β-spectrum of RaE by Konopinski and Uhlenbeck (1941). A.

539.165

8418. On the β^--disintegration of $^{80}_{35}$Br. J. Laberrigue-Frolow. *C.R. Acad. Sci.* [*Paris*] **234**, 2599–601 (*June* 30, 1952) *In French.*

The β^--radiation of Br^{80} was examined in a thick-lens spectrometer with a helicoidal baffle to eliminate β^+. The max. energy of the β^--spectrum was $E_{\beta_1 max} = 1{\cdot}99 \pm 0{\cdot}01$ MeV, and a Fermi plot indicated at least two components, with the second having $E_{\beta_2 max} = 1{\cdot}1$ MeV and intensity $0{\cdot}18$ of β_1. This suggests an excited level of Kr^{80} at ~ 1 MeV, but no trace of a γ-ray or of conversion electrons could be found. A. O. Stanesby

539.165

8419. Study of the β-spectra of Y^{90}_{39}, Y^{91}_{39}, Pr^{142}_{59}, Rb^{86}_{37}. J. Moreau and J. Perez y Jorba. *C.R. Acad. Sci.* [*Paris*] **235**, 38–40 (*July* 7, 1952) *In French.*

A β-spectrometer was used to study the shape and measure the maximum energy of the spectra. The maximum energies found were $2{\cdot}270 \pm 0{\cdot}020$, $1{\cdot}564 \pm 0{\cdot}010$, $2{\cdot}140 \pm 0{\cdot}010$ and $1{\cdot}785 \pm 0{\cdot}005$ MeV respectively. F. R. Holt

539.165

8420. Investigation of the beta-spectra of Be^{10}, K^{40}, Tc^{99}, and Cl^{36}. L. Feldman and C. S. Wu. *Phys. Rev.*, **87**, 1091–9 (*Sept.* 15, 1952).

The β-spectra of Be^{10}, K^{40}, Tc^{99} and Cl^{36} were investigated with the Columbia University solenoidal spectrometer and it was found that each exhibited a forbidden shape. An analysis of the spectra yields the following results: The spectrum of Be^{10} for which $\Delta J = 3$, can be explained equally well by $2T$ or $2A$ for no parity change and by $3T$ or $3V$ if the parity does change. Similarly, the spectrum of K^{40}, for which $\Delta J = 4$, can be accounted for by $3T$ or $3A$ if the parity changes and by $4T$ or $4V$ for no parity change. $\Delta J = 2$ for the decays of both Tc^{99} and Cl^{36}. These spectra can be explained only by $2T$ or $2V$ with values for k^2 of 45 for Tc^{99} and 18 for Cl^{36} ($k^2 = |A_{ij}|^2 \div |T_{ij}|^2$). If the true interaction prevailing in β-decay is but a single one of the 5 linearly independent interactions, then it follows from these spectrum analyses that it must be the tensor interaction. A linear combination of tensor with one or more of the other interactions is possible. It seems, however, that more information than is provided by spectrum studies alone is necessary to determine the exact form of such a linear combination. A.

539.165

8421. Electron spectra between 1 and 10 keV. H. Schneider, O. Huber, F. Humbel, A. de Shalit and W. Zünti. *Helv. Phys. Acta*, **25**, 259–78 (*No.* 3, 1952) *In German.*

The spectrum of low energy (1–10 keV) electrons has been measured for the cases of Ag^{107}, Ag^{109}, Tc^{99}, Hg^{197}, Au^{195}, Au^{199} and Au^{198} using a coincidence technique, in which the electrons are accelerated in a lens spectrometer. The apparatus is described, and the results are compared with the predictions of the single particle shell model. A.

539.165

8422. Cloud-chamber studies of the production of light "positive particles" near negative beta-ray emitters. G. Groetzinger and F. L. Ribe. *Phys. Rev.*, **87**, 1003–11 (*Sept.* 15, 1952).

A series of experiments was performed with a cloud chamber to investigate the nature of the particles producing the positive tracks near negative β-ray emitters reported in various investigations. Special emphasis was laid on the questions of whether the tracks are (1) due to electrons re-entering the source and (2) due to electrons emerging from the source multiply scattered to show an apparent positive curvature. While the second possibility can account for only a negligible fraction of the tracks, it is found that, depending upon the source arrangement and the manner of investigating cloud-chamber photographs, a considerable fraction of observed "positive" tracks may be due to electrons which re-enter or appear to re-enter the source. With stereoscopic analysis and an appropriate source arrangement, the fraction of spurious positive tracks may be reduced to a few per cent. With these precautions a ratio for P^{32} of positive particles to electrons of 3×10^{-4} is found. This ratio is increased by covering the source with carbon or lead. It is shown that the estimate of two electron masses previously obtained for the mass of these particles by comparing their multiple scattering with that of electrons was not influenced by the difference in the momentum distributions of the two species of particles used in the determination. A.

539.165.2

8423. The evaluation of the ratio F_n/F_0 in the theory of forbidden beta-transitions. P. Macklin, L. Lidofsky and C. S. Wu. Letter in *Phys. Rev.*, **87**, 391 (*July* 15, 1952).

It is pointed out that this can be done, since the tables of the Fermi function issued by the National Bureau of Standards are essentially tables of the Γ function of complex argument, the real part of which is ~ 1. J. Hughes

539.165.2

8424. Tables for the analysis of beta spectra. U. Fano. *Nat. Bur. Stand. Appl. Math. Ser., No.* 13, 61 *pp.* (1952).

The main tables give the value of the Fermi function

$$f(Z, \eta) = \eta^{2+2S} e^{\pm \pi\delta} |\Gamma(1 + S + i\delta)|^2$$

(η = momentum of ejected electron in units of mc, $S = (1 - Z^2/137^2)^{1/2} - 1$, Z = atomic number, $\delta = Z(1 + \eta^2)^{1/2}/137\eta$) for all values of Z up to 100 and in intervals of η of $0{\cdot}05$ for $\eta < 1$ and of $0{\cdot}1$ up to $\eta = 7$. Auxiliary Table 1 gives values of energy ε (units of mc^2), η, η/ε and kinetic energy T as functions of $B\rho$ (ρ = radius of curvature of track in magnetic induction B). Table 2 gives η, ε, η/ε and B_ρ as functions of T. Table 3 gives values of the non-relativistic electrostatic effect factor for negative and positive electrons. Table 4 illustrates the importance of relativistic corrections. Table 5 illustrates the accuracy of the Bethe–Bacher approximation. Table 6, with the help of a diagram of the screening potential, enables the percentage correction to the tabulated $f(Z, \eta)$ due to screening to be estimated. The Tables

refer to allowed spectra only. A clear introduction summarizes the underlying theory. L. PINCHERLE

539.166 : 539.164

8425. A study of the 350 keV γ-transition accompanying the α-emission AcC → AcC″. P. FALK-VAIRANT, J. TEILLAC AND C. VICTOR. *J. Phys. Radium*, **13**, 313–16 (*June*, 1952) *In French.*

The number of α-conversion/electron coincidences in AcC was measured using a proportional counter and thin-window G.M. counter, as $3{\cdot}0 \pm 0{\cdot}3$ per 100 disintegrations; the *K*-conversion coeff. for the 350 keV γ-ray is then $\alpha_K = 0{\cdot}18 \pm 0{\cdot}03$, and the transition is probably a mixture of magnetic dipole and electric quadrupole. Possible spin values for the ground and excited states are discussed.

A. O. STANESBY

539.166.08

8426. Line shape of monochromatic γ-rays in the scintillation spectrometer. D. MAEDER AND V. WINTERSTEIGER. Letter in *Phys. Rev.*, **87**, 537–8 (*Aug.* 1, 1952).

Calculations are made for various energies of γ-rays of the line shape for NaI crystals of different sizes. For small crystals only the primary Compton encounter is considered together with photoelectric absorption. For very large crystals, complete secondary absorption is assumed. From these extremes high-order approximations are obtained for intermediate cases. Pulse distributions given graphically also include the effect of back scattering of radiation from a long light pipe attached to the crystal. G. F. J. GARLICK

539.166.2

8427. The directional correlation of the Ni^{60} γ–γ cascade. H. AEPPLI, H. FRAUENFELDER, E. HEER AND R. RÜETSCHI. Letter in *Phys. Rev.*, **87**, 379–80 (*July* 15, 1952).

An anisotropy $[W(180)/W(90)] - 1 = 0{\cdot}148 \pm 0{\cdot}002$ is reported, differing from the theoretical 0·167 for a 4(*E*2)2(*E*2)0 cascade. No alternative assignments could be found. In a test for electron shell effects the correlation was unaltered by fields of up to 15 000 gauss. J. J. WILKINS

539.166.2

8428. Some observations on the gamma-radiation from polonium. R. W. PRINGLE, H. W. TAYLOR AND S. STANDIL. Letter in *Phys. Rev.*, **87**, 384–5 (*July* 15, 1952).

Only a component at 804 ± 5 keV was found in the range 100 keV to 2 MeV. Soft radiation of mean energy 77 ± 2 keV and 25–40% intensity was also detected. Less than 1% of the soft radiation was coincident (<0·3 microseconds) with the 804 keV radiation. J. J. WILKINS

539.166.2

8429. Gamma-gamma angular correlation in Cd^{114}. E. D. KLEMA AND F. K. MCGOWAN. Letter in *Phys. Rev.*, **87**, 524 (*Aug.* 1, 1952).

Measurements from 90° to 160° gave $W(\theta) = 1 + 0{\cdot}084\cos^2\theta + 0{\cdot}106\cos^4\theta$, consistent with a 2, 2, 0 cascade. The first γ-ray is (97% M.D. + 3% E.Q.). A cross-over of about 6% intensity was detected. J. J. WILKINS

539.166.74

8430. Small angle coherent scattering of gammas by bound electrons. J. S. LEVINGER. *Phys. Rev.*, **87**, 656–62 (*Aug.* 15, 1952).

Franz has shown that for nonrelativistic changes of photon momentum (q) the coherent scattering of gammas by bound electrons reduces to the form factor calculation. The near-relativistic region is considered by an expansion in q/mc. The corrections to the form factor calculation are very small for small atomic numbers, the order of magnitude being $(Z/137)(q/mc)$. Numerical results for scattering by *K* electrons of tin give an increase of the amplitude of 25% above the form factor value for $q/mc = 1{\cdot}5$ and a smaller change for smaller values of q. The results are incomplete since the effects of binding in the intermediate state are neglected. A.

539.166.74

8431. Elastic scattering of gammas by bound electrons. P. GREIFINGER, J. LEVINGER AND F. ROHRLICH. Letter in *Phys. Rev.*, **87**, 663 (*Aug.* 15, 1952).

Calculations are reported of Rayleigh scattering of Co^{60} 1·332 MeV γ-rays by *K*-electrons of Pb at 180° angle. J. J. WILKINS

539.166.74

8432. Nuclear scattering of 17-MeV gamma-rays. M. B. STEARNS. *Phys. Rev.*, **87**, 706–15 (*Sept.* 1, 1952).

The nuclear scattering of γ-rays from the $Li^7(p, \gamma)Be^8$ reaction has been measured. The scatterers used were Bi, Pb, Sn and Cu. The observed Z dependence of the elastically scattered γ-rays varied as $Z^{2\cdot5\pm0\cdot5}$, while the inelastically scattered γ-rays varied at a rate greater than $Z^{2\cdot9\pm0\cdot3}$. An appreciable amount of inelastic scattering was observed. The elastic scattering results combined with previously measured integrated $\gamma - n$ cross-sections of Cu are in agreement with a γ-ray absorption curve centred around 17–18 MeV and having a width of 4–6 MeV. A.

539.166.74

8433. Gamma-ray-diffusion experiments in water. M. A. VAN DILLA AND G. J. HINE. *Nucleonics*, **10**, 54–8 (*July*, 1952).

Experiments were carried out with a small liquid ($C_{10}H_{22}$) ionization chamber and various compact γ-sources viz.: Hg^{203} (0·279 MeV); Au^{198} (0·411 MeV) Co^{60} (1·25 MeV, av.) and Ra, inside a large steel tank of water. Measurements were made at various source-detector separations, in air, fully immersed, and at various levels above and below the surface. The results are interpreted in terms of absorption and scattering. The effects of scattering are more pronounced at low γ-ray energies and with small separations (< 1 m.f.p.) the presence of the water actually increases the dosage received from Hg^{203} and Au^{198} sources. Build-up factors are given as a function of source-detector distance for each source. The application of these results to the calculation of dosages received from γ-ray sources implanted in tissue is described. L. R. SHEPHERD

539.166.75

8434. Gamma-ray absorption measurements. S. A. COLGATE. *Phys. Rev.*, **87**, 592–601 (*Aug.* 15, 1952).

γ-ray absorption measurements have been made

using a NaI energy-selective scintillation counter with radioactive source γ-rays of 0·411, 0·664, 1·33 and 2·62 MeV energy. A range of absorbers from H to U was used. The final absorption coefficient was determined to $\pm$ 0·2% root-mean-square statistical accuracy. Additional absorption measurements were made with nuclear reaction γ-rays at the energies 4·47, 6·13 and 17·6 MeV with the same absorbers. A statistical accuracy of $\pm$2% was attained. A comparison of theory to experiment is presented and no radical differences are observed. A.

539.166.83

8435. On the internal conversion radiations of ^{232}Th. G. Albouy. Letter in *J. Phys. Radium*, **13**, 309–10 (*May*, 1952) *In French.*

G5 emulsions were impregnated with a thorium nitrate–sodium citrate complex, free of RTh. 20% of the Th^{232} α-particles were associated with electrons, indicating conversion of a 75 keV γ-ray from MsTh1.

J. J. WILKINS

539.166.83

8436. Spectrum of internal conversion electrons emitted in the transmutation radiothorium $\rightarrow$ thorium X. S. Rosenblum, M. Valadares and M. Guillot. *C.R. Acad. Sci.* [*Paris*] **235**, 238–40 (*July* 21, 1952) *In French.*

Six lines were resolved, with energies of 65·8, 68·9, 79·7, 80·4, 83·3 and 84·0 keV, and relative intensities 100, 84, 29, 23, 13 and 2 respectively. All lines are accounted for by conversion of an 84·3 keV γ-ray, emitted from an excited state of spin 2 in ThX.

J. J. WILKINS

539.166.83

8437. Internal conversion of gamma-ray transitions in the *L*-subshells. J. W. Mihelich. *Phys. Rev.*, **87**, 646–51 (*Aug.* 15, 1952).

A number of internally converted γ-transitions have been investigated with high resolution β-spectrographs and the relative intensities of conversion electron lines from the three *L*-subshells obtained. Generalizations are made for *L*-conversion as related to multipole order. The magnetic transitions investigated are converted in the L_{I}- and L_{III}-shells, the ratio $L_{\mathrm{III}}/L_{\mathrm{I}}$ increasing with increasing multipole order. Less can be said about electric transitions; but *L*-conversion takes place mainly in the L_{II}- and L_{III}-shells for the transitions studied. A.

539.166.835

8438. The pair-production cross section for high energies. P. A. Fraser. Letter in *Phys. Rev.*, **87**, 523 (*Aug.* 1, 1952).

The same numerical results were found for Hg when the Thomas–Fermi and Hartree models were used to calculate the form factor in Bethe's formula for pair production. W. J. SWIATECKI

539.166.92

8439. On the components of the ionization current from γ-rays. I. V. Estulin. *Zh. Eksper. Teor. Fiz.*, **22**, 414–20 (*No.* 4, 1952) *In Russian.*

The ionization current produced by γ-rays from Ra and RaTh entering a gap-type ionization chamber used to measure the equilibrium intensities of electrons from Pb, Sn, Cu, Fe, Al and C, is analysed into 3 components: electrons produced directly in the front and rear walls and electrons due to consecutive reflections from the walls. Experimental results are plotted against *Z*. W. J. SWIATECKI

539.166.92 : 578.088.5

8440. Electron energies and ion densities in water irradiated with 200 keV, 1 MeV and 25 MeV radiation. D. V. Cormack and H. E. Johns. *Brit. J. Radiol.*, **25**, 369–81 (*July*, 1952).

A detailed theoretical study, deriving distributions of ion densities along electron tracks for 6 different qualities of radiation. Starting from the spectral distributions derived from absorption measurements, the analysis comprises: (1) calculation of initial distribution of electron energies due to photoelectric, Compton and pair-production processes, (2) calculation of distribution of these energies at a given point in the absorbing material, (3) calculation of the resulting ion densities along tracks of electrons. It is shown that the mean ion densities normally calculated on the basis of average electron energies are unreliable, and the averaging must be carried out as the final step in an analysis as above if it is to be a valid index of biological effect. The mean ion densities for 3 principal radiation qualities are, 200 kV, 53 ion pairs per μ; Co^{60} and radium, 7·5 ion pairs per μ; 25 MeV betatron, 6·2 ion pairs per μ. F. T. FARMER

539.167.3

8441. Modern radiochemical practice. G. B. Cook and J. F. Duncan. *Oxford, Clarendon Press* (1952) 428 *pp.*

This essentially practical work discusses the following topics: application of radiotracer techniques in chemistry; the laws of radioactive decay; practical determination of half-lives and energies of nuclear radiation; detection and measurement of nuclear radiation; functions and use of auxiliary electronic apparatus (detailed electronic circuits have not been included); chemical and physical considerations of radioisotope production and the factors affecting choice of radiotracer; comparative and absolute measurement of activity with a G.M. counter using solid, liquid or gaseous samples; health aspects of radioactivity and how they affect laboratory technique and design at radiotracer levels. A.

NUCLEAR REACTIONS 539.17

539.17 : 523.11

The polyneutron theory of the origin of the elements. *See Abstr.* 7877

539.172

8442. Cascade theories with ionization loss. H. Messel and R. B. Potts. *Phys. Rev.*, **87**, 759–67 (*Sept.* 1, 1952).

Analytical solutions have previously been given for the number distribution functions and for the general moments of the electron-photon and nucleon cascades neglecting ionization losses (approximation *A*). Solutions are now given for the moments of the electron-photon and proton-neutron cascades taking

nto account energy loss, via ionization, by electrons ind protons (approximation *B*). The diffusion quations for the differential moment functions, which ield the required factorial moments by a simple ntegration over the energy variables, are transformed y Laplace–Mellin transforms to matrix recurrence elations, the general solution of which is obtained in he form of power series. From these series, solutions or the moments in a form suitable for numerical alculations are obtained by a generalization of the nethod used by Bhabha and Chakrabarty for the first noments of the electron-photon cascade and by Messel in the proton-neutron cascade. To a first approximation, the solutions for the moments in approximation *B* are expressed as a correction factor multiplying the solutions obtained in approximation *A*. A.

539.172

8443. Conservation of isotopic spin in nuclear reactions. R. K. ADAIR. *Phys. Rev.*, **87**, 1041–3 (*Sept.* 15, 1952).

The effects of the charge independence of nuclear forces on nuclear reaction experiments is discussed. It is pointed out that charge independence establishes relationships between cross-sections for some reactions and results in forbidding certain other reactions. A.

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 8291–2, 8302–7

539.172

8444. Fast meson interactions in nuclear emulsions. I. π^- mesons. H. BRADNER AND B. RANKIN. *Phys. Rev.*, **87**, 547–52 (*Aug.* 15, 1952).

π^--mesons produced in the Berkeley cyclotron are collimated and monochromatized to 35 ± 2 MeV by a toothed channel in the magnetic field of the cyclotron. Tracks of these mesons obtained in Ilford G5 emulsions are followed and studied for scatter, nuclear stars, and disappearances in flight. The energy distribution of the accepted mesons is critically examined and a low-energy cut-off for the initial energy is established. 65% of the meson track is above 30 MeV in the region of observation, while the remaining 35% may drop to 20 MeV. The selection of the high-energy particles and their identification by small-angle scatter and grain density is discussed. Proton contamination is eliminated largely by small-angle scatter. Electrons are ruled out by grain count. In 902 cm of track there are 5 disappearances and 26 scatters greater than 30°; 4 of the scatters are detectably inelastic, with energy transfer greater than 18 MeV. The combined cross-section for stars, disappearance and inelastic scatters is equal to the cross-section for elastic scatters. The measured value for total nuclear interaction is statistically compatible with the combined nuclear area for the responsible elements, O, C, Br and Ag. A.

539.172

8445. Fast meson interactions in nuclear emulsions. II. π^+ mesons. B. RANKIN AND H. BRADNER. *Phys. Rev.*, **87**, 553–7 (*Aug.* 15, 1952).

π^+-mesons produced in the exterior proton beam of the Berkeley cyclotron are bent by an auxiliary magnet and detected in Ilford G5 emulsions. These mesons are studied in the same way as were the π^--mesons in Pt I. Extra care is taken to eliminate protons from the data and a special technique is developed to make more efficient small-angle scattering measurements. The average initial energy, 45·5 MeV, is slightly higher than that of the π^--mesons, and the spread in energy is greater. Less than 18% of observed track is less than 30 MeV and 98% of it is over 22 MeV. No disappearances are found over the 902 cm of track. Fewer are expected than were found in Pt I, since the average number of charged prongs is greater for π^+-induced stars than for π^-. No inelastic scatters are found among the 5 scatters greater than 30°. Though the star frequency is the same as in the previous experiment, the frequency for scatters is significantly lower, a fact which is not explained by the slightly higher energy. A statistical upper bound on the cross-section for π^+ scattering on H is obtained as $2{\cdot}3\times10^{-26}$ cm². A.

539.172.13

8446. The excitation of nuclei by the Coulomb field of charged particles. K. A. TER-MARTIROSYAN. *Zh. Eksper. Teor. Fiz.*, **22**, 284–96 (*No.* 3, 1952) *In Russian.*

Cross-sections for collisions without penetration of the Gamow barrier are analysed. When the collision is almost elastic a perturbation treatment in which the trajectory of the impinging particle is described classically gives explicit formulae for all multipole orders of the excitation in terms of the nuclear multipole moments. When the energy transfer is large, Coulomb wave functions are used instead. Only dipole excitations are then tractable. The special case of large impact parameters is treated. The cross-sections are 10^{-26}–10^{-29} cm².

W. J. SWIATECKI

539.172.13

8447. The reactions $p + d \rightarrow \pi^+ + H^3$ and $p + d \rightarrow \pi^\circ + He^3$. M. RUDERMAN. Letter in *Phys. Rev.*, **87**, 383–4 (*July* 15, 1952).

Charge independence leads to $d\sigma(p + d \rightarrow He^3 + \pi^\circ)/d\sigma(p + d \rightarrow H^3 + \pi^+) = \frac{1}{2}$. The differential cross-section for mesons from $p + d \rightarrow H^3 + \pi^+$ with 345 MeV protons is estimated from the known $d\sigma(p + p \rightarrow \pi^+ + D)$ using an impulse approximation. The total σ is $\sim 1{\cdot}3\times10^{-29}$ cm².

W. J. SWIATECKI

539.172.13

8448. Excited states of lithium-6 and lithium-7. W. FRANZEN AND J. G. LIKELY. Letter in *Phys. Rev.*, **87**, 667–8 (*Aug.* 15, 1952).

Protons and deuterons from the irradiation of natural Li with 18 MeV protons were examined using a NaI scintillation counter as detector. The results are compared with those of other workers; a new broad level in Li^7 was found at 6·56 ± 0·12 MeV.

A. O. STANESBY

539.172.13

8449. Gamma-ray yield from the proton bombardment of boron. L. W. COCHRAN, J. L. RYAN, H. H. GIVIN, B. D. KERN AND T. M. HAHN. Letter in *Phys. Rev.*, **87**, 672 (*Aug.* 15, 1952).

Resonances at 163 keV and at 670 ± 15 keV

($\Gamma = 390$ keV) were found. No further resonances were detected up to 1·0 MeV proton energy.

J. J. WILKINS

539.172.13

8450. Angular distributions of charged particles from nuclear reactions. P. M. ENDT, D. DE JONG, M. BOGAARDT AND B. KOUDIJS. *Physica*, **18**, 399–406 (*June–July*, 1952).

A description is given of equipment built for the measurement of angular distributions of charged particles released in nuclear reactions. Thin targets are bombarded by deuterons or protons accelerated by a cascade-generator and analysed by a magnet. Secondary particles from the target are detected by means of photographic emulsions placed at 15° intervals round the target. For results obtained with specific reactions see abstracts following. A.

539.172.13

8451. Angular distribution of long range protons from the $Be^9(d, p)Be^{10}$ reaction. D. DE JONG AND P. M. ENDT. *Physica*, **18**, 407–14 (*June–July*, 1952).

With the equipment described in the preceding abstract the angular distribution was measured of long range protons from the $Be^9(d, p)Be^{10}$ reaction at a deuteron bombarding energy of 470 keV. The distribution shows a pronounced maximum in backward direction. Series expansion of the distribution into spherical harmonics is shown to be simple, terms containing $P_4(\cos\theta)$ or higher being negligible. A short discussion is given of the theoretical implications of the observed distribution. A.

539.172.13

8452. Angular distributions of protons from the $C^{13}(d, p)C^{14}$ and $C^{12}(d, p)C^{13}$ reactions. B. KOUDIJS, P. M. ENDT, J. M. VAN DER HART AND P. J. W. PALMEN. *Physica*, **18**, 415–20 (*June–July*, 1952).

See also the two preceding abstracts. Angular distributions have been measured of protons from the ground-state transitions of the reactions $C^{13}(d, p)C^{14}$ and $C^{12}(d, p)C^{13}$ at a deuteron bombarding energy of 470 keV. The target consisted of barium carbonate enriched to 56% in C^{13} content. The angular distribution of $C^{13}(d, p)C^{14}$ protons shows a pronounced maximum in forward direction and a minimum at 126°. The $C^{12}(d, p)C^{13}$ proton distribution shows minima in forward and backward directions and a maximum at 97°. The ratio of $C^{12}(d, p)C^{13}$ over $C^{13}(d, p)C^{14}$ total cross-sections is equal to 8·7. A.

539.172.13

8453. Angular distributions of four proton groups from the $B^{10}(d, p)B^{11}$ reaction. P. M. ENDT, C. H. PARIS, H. M. JONGERIUS AND F. P. G. VALCKX. *Physica*, **18**, 423–8 (*June–July*, 1952).

Angular distributions have been measured of 4 proton groups from the $B^{10}(d, p)B^{11}$ reaction corresponding to transitions to the ground state [group (0)] and the 3 lowest excited states of B^{11} [groups (1), (2) and (3)]. A thin target of natural B was bombarded with 310 keV deuterons and protons were detected by nuclear emulsions placed at 15° intervals round the target. Protons of different groups were distinguished by their range in the emulsion. Angular distributions of groups (0) and (2) are peaked in the forward direction while those of groups (1) and (3) are more nearly isotropic. By integration over solid angle total cross-sections were determined. They amount to 48 microbarn for group (0), 18 microbarn for group (1), 76 microbarn for group (2) and 11 microbarn for group (3). A.

539.172.13

8454. Interpretation of the long range protons from the deuteron bombardment of Be^9. W. W. TRUE AND L. DIESENDRUCK. Letter in *Phys. Rev.*, **87**, 381–2 (*July* 15, 1952).

The angular distribution at 1–2·2 MeV [Abstr. 7330 (1952)] shows a forward peak which can be accounted for by the stripping of a $l_n = 1$ neutron, the remaining distribution being smooth enough to be explained by compound nucleus formation.

W. J. SWIATECKI

539.172.13

8455. Neutrons from deuteron bombardment of N^{14}. W. B. ROSE, E. L. HUDSPETH AND N. P. HEYDENBURG. Letter in *Phys. Rev.*, **87**, 382–3 (*July* 15, 1952).

An analysis of recoil protons in emulsions placed at 0° and 90° to a 1·7 MeV beam on NH_4NO_3 targets shows that the only Q-values in the reaction $N^{14}(d, n)O^{15}$ are 5·1 and 0·2 MeV. Other peaks are attributed to C and D contamination. W. J. SWIATECKI

539.172.13

8456. Evidence for the polarization of the protons produced in the D–D reaction. G. R. BISHOP, J. M. WESTHEAD, G. PRESTON AND H. H. HALBAN. Letter in *Nature* [*Lond.*] **170**, 113 (*July* 19, 1952).

2 MeV protons produced in heavy ice at a rate of 10^8 sec^{-1} at 120° to a 300 keV D beam were scattered through 75°–120° (centre of mass) by He at 1 atm. and detected by a proportional A counter. From the dependence of the cross-section on the angle between the scattering planes it is deduced that the polarization of the protons is (30 ± 6)%.

W. J. SWIATECKI

539.172.13

8457. The decay of the 2·4 MeV level in ^9Be. G. A. DISSANAIKE AND J. O. NEWTON. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 675–6 (*Aug.*, 1952).

α–n coincidences were obtained from the irradiation of separated B^{11} with 425 keV deuterons, $B^{11}(d, \alpha)Be^{9*}$, using anthracene and terphenyl/toluene scintillation counters to detect α-particles and neutrons resp.; the delay spectrum of the neutrons was investigated as a function of the angle of detection, with a resolving time of 8 mμsec. A. O. STANESBY

539.172.13

8458. Angular distributions of the Be^9 + D neutrons. J. S. PRUITT, S. S. HANNA AND C. D. SWARTZ. Letter in *Phys. Rev.*, **87**, 534–5 (*Aug.* 1, 1952).

Neutrons from $Be^9(d, n)B^{10*}$ (excitation 0, 0·76, 1·78, 2·22, 3·68 MeV) were observed between 15° and 140° by means of recoil protons in emulsions. At 3.68 MeV Butler's stripping theory (with $l_p = 1$) gives agreement; at lower energies there is an increasing yield in the backward direction ascribable to compound nucleus formation. W. J. SWIATECKI

539.172.13

8459. Neutrons from the disintegration of phosphorus by deuterons. S. C. SNOWDON. *Phys. Rev.* **87**, 1022–5 (*Sept.* 15, 1952).

The neutron spectrum at 0° and 90° from the

$^{31}(d, n)S^{32}$ reaction has been investigated using uclear emulsions. The energies of the excited states S^{32} are 0·5, 1·5, 2·2, 2·7, 3·3, 3·8, 4·1, 4·5, 4·9, ·2 and 5·5-MeV, each with an uncertainty of about ±0·1-MeV. A.

539.172.3

460. Relative yields of photonuclear reactions. . S. EDWARDS AND F. A. MACMILLAN. Letter in *hys. Rev.*, **87**, 377 (*July* 15, 1952).

Yields are listed from 44 reactions, mainly (γ, n) nd (γ, p), produced by a 70-MeV synchrotron beam. ome (γ, pn), $(\gamma, 2n)$, $(\gamma, 2p)$ and $(\gamma, 2pn)$ yields are ncluded. The (γ, pn) yields are $\simeq(\gamma, p)$ yields, and imilarly the $(\gamma, 2pn)$ yields are $\simeq(\gamma, 2p)$ yields.

J. J. WILKINS

539.172.3

461. The reaction $N^{14}(\gamma, 2n)N^{12}$. W. K. H. 'ANOFSKY AND D. REAGAN. Letter in *Phys. Rev.*, **87**, 43 (*Aug.* 1, 1952).

Samples of $(N_6C_3H_6)$ were irradiated with γ's onverted from a 120 MeV linear accelerator electron eam by a 0·040 in W foil. A 12·5 msec period was etected by a focusing β-spectrometer and a 5-channel elayed gate arrangement. The integral cross-section $\sigma dE = (5{\cdot}5 \pm 2) \times 10^{-4}$ MeV barns. W. J. SWIATECKI

539.172.3

462. Search for betatron induced, low Z, activities f short half-life. R. K. SHELINE. *Phys. Rev.*, **87**, 57–60 (*Aug.* 15, 1952).

B^8 has been observed as a 0·61 ± 0·11 sec positron mitter produced by the following reactions: $^{10}(\gamma, 2n)B^8$, $B^{11}(\gamma, 3n)B^8$, and $C^{12}(\gamma, p3n)B^8$. Li^9 as been observed as a 0·19 ± 0·05 sec $\beta-$ emitter roduced by the reaction, $B^{11}(\gamma, 2p)Li^9$. Irradiation f elements from $Z = 3$ to $Z = 9$ with a 0–50 MeV -ray spectrum failed to induce any other short-lived ctivities. In spite of this, B^{13}, C^9 and O^{13} are not uled out as short-lived activities. Li^4 is not produced observable amounts through the reaction $i^6(\gamma, 2n)Li^4$ if it has a half-life between 0·1 sec and min; it is probably particle unstable. A.

539.172.3

463. Identification and yields of $(\gamma, \alpha n)$ reactions. R. B. HOLTZMAN AND N. SUGARMAN. *Phys. Rev.*, **87**, 33–9 (*Aug.* 15, 1952).

The $(\gamma, \alpha n)$ reaction was studied in several nuclides y irradiation with photons of 50- and 87-MeV naximum energy from the betatron. By use of radio-hemical techniques it was shown that C^{11} is produced rom O, F^{18} from Na, P^{30} and P^{32} from Cl, Ga^{70} from s, As^{74} and As^{76} from Br, and Zr^{87} from Mo. Except or P^{32}, it is proposed that these nuclides are produced y the $(\gamma, \alpha n)$ reaction. The yields of these nuclides elative to N^{13} from the $N^{14}(\gamma, n)N^{13}$ reaction, and hose of other nuclides observed in this study are iven. A.

539.172.3

464. The $Cu^{63}(\gamma, n)Cu^{62}$ cross section. V. E. KROHN, JR, AND E. F. SHRADER. *Phys. Rev.*, **87**, 85–7 (*Sept.* 1, 1952).

The cross-section for the reaction $Cu^{63}(\gamma, n)Cu^{62}$ as been determined as a function of energy by the nalysis of the X-ray activation curve. D_2O loaded emulsions and a pair spectrometer were used as monitors and the results obtained are in good agreement with the results of recent measurements which depend upon the calculated response of r-meters. A.

539.172.3

8465. Gamma–neutron reactions in fluorine. R. J. HORSLEY, R. N. H. HASLAM AND H. E. JOHNS. *Phys. Rev.*, **87**, 756–8 (*Sept.* 1, 1952).

The cross-sectional curves for the reactions $F^{19}(\gamma, n)F^{18}$ and $F^{19}(\gamma, 2n)F^{17}$ have been determined by measurement of the induced positron activities. The (γ, n) cross-sectional curve rises almost vertically from the threshold to a value of about 2 mb, remains constant for about 3 MeV, and then increases again to a maximum value of 3·48 mb at 20 MeV. The $(\gamma, 2n)$ cross-sectional curve has a peak value of 0·66 mb at about 26 MeV. The integrated cross-sections for the (γ, n) and $(\gamma, 2n)$ reactions are 0·039 and 0·0024 MeV-barns, respectively. However, the $(\gamma, 2n)$ reaction is evaluated only up to its peak position at 26 MeV. A new value of 60 ± 1 seconds is reported for the F^{17} activity. A.

539.172.4

8466. The disintegration of oxygen and nitrogen by 14·1-MeV neutrons. A. B. LILLIE. *Phys. Rev.*, **87**, 716–22 (*Sept.* 1, 1952).

Oxygen and nitrogen contained as a gas in a cloud chamber were bombarded by 14·1-MeV neutrons. From the disintegrations of these nuclei the following data have been collected: (*a*) the range-energy relations of C^{13} in the energy range 0–5 MeV, and the range-energy curve of B^{11} from 0–7 MeV; (*b*) the excited states of the nuclei C^{13}, B^{11}, N^{15} and N^{16}; (*c*) the angular distributions of the α-particles emitted in the $O^{16}(n, \alpha)C^{13}$ and $N^{14}(n, \alpha)B^{11}$ reactions; (*d*) the cross-sections for some of the reactions taking place. A.

539.172.4

8467. A study of the spectrum of the neutrons of low energy from the fission of U^{235}. T. W. BONNER, R. A. FERRELL AND M. C. RINEHART. *Phys. Rev.*, **87**, 1032–4 (*Sept.* 15, 1952).

A cloud chamber has been used to determine, in the energy range 0·05 to 0·7 MeV, the distribution of prompt neutrons produced by the fissions of U^{235} in a thermal neutron beam. The ratio of proton recoils in the energy range 0·05 to 0·6 MeV to the recoils in the energy range 0·6 MeV to infinity was also determined. The data fit a distribution function $N(E) = \sinh(2E)^{\frac{1}{2}}e^{-E}$. A.

539.172.4

8468. The neutron energy spectrum from U^{235} thermal fission. D. L. HILL. *Phys. Rev.*, **87**, 1034–7 (*Sept.* 15, 1952).

A Ranger measurement of the distribution-in-range of knock-on protons from thin paraffin layers indicates the distribution-in-energy from 0·4 MeV to 7 MeV of the neutrons emitted from U bombarded by neutrons from the thermal column of the Argonne Heavy Water Reactor. The spectrum shows a broad maximum near 0·75 MeV and follows closely an exponential drop from 2 MeV to 7 MeV with a relaxation energy of 1·55 MeV. The observed neutron intensity does not go to zero below 16 MeV. A.

539.172.4

8469. Energy spectrum of neutrons from thermal fission of U^{235}. B. E. Watt. *Phys. Rev.*, **87**, 1037–41 (*Sept.* 15, 1952).

A proton recoil counter has been used to determine the neutron spectrum, in the energy range 3·3–17 MeV, of a beam produced by irradiating 95 % U^{235} (metal) in the central experimental hole of the Los Alamos Homogeneous Reactor. Most of the fissions were induced by slow neutrons. The data are combined with those obtained by D. Hill and by T. W. Bonner, R. A. Ferrell and M. C. Rinehart (see preceding abstracts); the composite spectrum so obtained extends from 0·075 to 17 MeV. Fits with two general formulae are discussed. A.

539.172.4

8470. Distributions-in-energy for alpha-particles and protons from U^{235} fission. D. L. Hill. *Phys. Rev.*, **87**, 1049–51 (*Sept.* 15, 1952).

The Ranger has been applied to obtain the distributions-in-range for the α-particles and protons emitted from a thin film of U^{235} irradiated by thermal neutrons. For the α-particles the corresponding distribution-in-energy was obtained from 5·2 MeV to 50 MeV, showing appreciable intensity above 35 MeV and being well approximated in the high intensity region by a Gaussian curve centered at 15·2 MeV and with a 4·3 MeV r.m.s. half-width. The total intensity observed in this energy region corresponds to one α-particle in 220 fissions. The proton intensity was found to be low above 2·1 MeV but to rise sharply as the energy was diminished to the limit of observation at 1·4 MeV, indicating about one proton with an energy in excess of 1·4 MeV emitted per 5000 fissions. A.

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

8471. The phenomenological analyses of mesonic processes. Y. Yamaguchi. *Progr. Theor. Phys.*, **6**, 772–87 (*Sept.–Oct.*, 1951).

Discusses qualitatively the available data concerning artificially produced π-mesons: photo-meson production from nucleons and deuterons. scattering of mesons by nucleons, meson production by nucleon–nucleon collision, and the slow π^--meson capture by H and D. Phenomenological considerations rather than the current meson theoretical calculations are adopted. A.

539.18

8472. Production of charged π-meson by γ-ray—higher order corrections. Z. Koba, T. Kotani and S. Nakai. *Progr. Theor. Phys.*, **6**, 849–90 (*Sept.–Oct.*, 1951).

The effective cross-section for the production of charged π-meson by γ-ray is calculated by the Lorentz-covariant perturbation method, including the effects of order $e^2f^4(e^2g^4)$. The pseudoscalar meson field with both pseudoscalar and pseudovector coupling has been employed. Virtual mesons in intermediate states can be either charged or neutral. The procedure of the renormalization of mass and mesic charge (f, g) is sufficient to determine unambiguously the finite fourth order matrix element except for one term to be interpreted as "electric charge of neutron," which was removed. The general requirement of gauge invariance restricts the possible interaction of nucleon and meson with photon to only four types; consequently numerous Dyson diagrams were divided into certain gauge invariant classes and then reduced according to Dyson's general programme, to obtain ultimately those four types. In the second approximation the anomalous magnetic moment of the nucleon plans an essential part; consequently the lack of any correct analysis for the latter complicates results considerably. Moreover, in the $\gamma - \pi$ process the behaviour of the magnetic corrections, dependent on the incident energy of the photon, are comparable with the static effects. Three provisional measures have been taken with regard to the anomalous moments and the resulting values for the various combinations and couplings of meson fields are compared and discussed. Though the results depend upon the choice of these possibilities, it is shown, in general, that the fourth-order contributions turn out, for the energy region of the present experiments (incident X-ray being about 330 MeV), not so large compared with the second order in the case of the symmetrical combination, while they are of the same order of magnitude as the second order in the case of the "charged plus pure neutral" combination. Finally, some qualitative aspects of the $\gamma - \pi$ process are discussed, which might be valid independently of the order of approximation. A.

539.18

8473. The decay scheme of the V^0-particle. K. A. Brueckner and R. W. Thompson. Letter in *Phys. Rev.*, **87**, 390–1 (*July* 15, 1952).

The 3 tests for the presence of a neutral particle n_0 in $U^0 \rightarrow p + \pi + Q + n_0$, viz., coplanarity, distribution of Q, magnitude of net transverse momentum, are discussed quantitatively. In the case of a light n_0 and a fast V_0 the most probable departure from coplanarity is zero with a width of a few degrees: present data are not accurate enough to rule out an n_0.

W. J. Swiatecki

539.18

8474. Meson masses. K. M. Guggenheimer. Letter in *Nature* [*Lond.*] **170**, 158 (*July* 26, 1952).

Relativistic energy eigenvalues of a rigid rotator (of electronic dimensions) and systems of such rotators forming a line, triangle or tetrahedron are compared with μ, π, V and κ meson masses.

W. J. Swiatecki

539.18

8475. Production and interaction of mesons at very high energies. D. Lal, Y. Pal, B. Peters and M. S. Swami. Letter in *Phys. Rev.*, **87**, 545 (*Aug.* 1, 1952).

About 400 charged and neutral shower particles (ratio $1 \cdot 0 \pm 0 \cdot 1$) produced by a 2×10^{14} eV Mg nucleus inside a 7·4° cone were studied over an

ggregate track length of 3 m in emulsion. The ngular distribution is consistent with Fermi's theory. 'en secondary interactions show that meson-produced howers lead to low excitation of the target nucleus. W. J. SWIATECKI

539.18

476. Possibility of obtaining experimental information concerning the meson-meson interaction. K. A. BRUECKNER AND K. M. WATSON. *Phys. Rev.*, **87**, 21–2 (*Aug.* 15, 1952).

The observation of correlated pairs of mesons ssociated with high-energy stars is suggestive of a trong attractive interaction between pairs of π-nesons. If such an interaction exists, it should ppear in a relatively simple manner in the production f pairs of mesons by protons or γ — rays near the nergetic threshold. The observation of a marked orrelation in energy and angle between the mesons f a pair produced in a single event should lead to uantitative information concerning the meson-meson nteraction. A.

539.18

477. The absorption of slow π^- mesons by He^3. . M. L. MESSIAH. *Phys. Rev.*, **87**, 639–46 (*Aug.* 15, 952).

A theoretical investigation of the absorption of $^-$-mesons by He^3 has been carried out in the impulse pproximation, using the operators of the weak oupling theory. A similar calculation of π^--absorpon in H and D when compared with experiment fixes ne constants in the theory. Consequently the ranching ratios between the 6 competing absorption rocesses in He^3 can be predicted unambiguously. 'omparison of these ratios and of the calculated -ray spectrum with experiment should provide a ood test of the theory. A.

539.18

478. A note on the ζ^0-meson. M. F. KAPLON AND). M. RITSON. Letter in *Phys. Rev.*, **87**, 664 (*Aug.* 15, 952).

Twenty-one showers of mean charged multiplicity - 20 were examined for correlations between pairs f particles. Of the 31 pairs found, 26 can be ccounted for by electron positron pairs from π^0. he pairs in the stars of Danysz *et al.* [Abstr. 9627 1952)] might be due to the importance of meson-eson forces at the low energies examined there. W. J. SWIATECKI

539.18

479. The total cross section of positive pions in ydrogen. S. W. BARNES, D. L. CLARK, J. P. PERRY ND C. E. ANGELL. Letter in *Phys. Rev.*, **87**, 669 *Aug.* 15, 1952).

The cross-section at a mean pion energy of 37 MeV t 160° ± 10° to the 240 MeV proton beam was ound to be 12·4 ± 3 mbarns by measuring the tenuation produced by C and CH_2 blocks inserted etween the crystals of a trans-stilbene scintillation ounter telescope. W. J. SWIATECKI

539.18

480. Elastic π-carbon scattering. D. C. PEASLEE. *hys. Rev.*, **87**, 862–5 (*Sept.* 1, 1952).

Elastic scattering of 60 MeV π-mesons on C is analysed to determine the following qualitative features of elementary π-nucleon scattering at this energy: p-wave scattering is predominant, with some s-wave interference at a relative phase that favours backscattering. The rather crude interpretation does not indicate d-wave scattering. Spin flip scattering is essentially absent from the C^{12} scattering. The Coulomb interference provides an absolute calibration, from which it is inferred that the p-wave "resonance" energy lies above 60 MeV. A.

539.18

8481. The absorption of a π^- meson from the K-shell of H^3. S. A. BASRI. *Phys. Rev.*, **87**, 866–70 (*Sept.* 1, 1952).

The branching ratio, R, of the nonradiative to radiative absorption of a π^--meson by H^3 is calculated on the basis of a phenomenological pseudoscalar weak coupling theory. In order to make R independent of many unknown quantities, it is calculated by means of the formula $R = (R_n/R_\gamma)R_D$, where $R_n \equiv W(\pi^- + T \to 3N)/W(\pi^- + D \to 2N)$ $R_\gamma \equiv W(\pi^- + T \to 3N + \gamma)/W(\pi^- + D \to 2N + \gamma)$, and R_D is the corresponding branching ratio in deuterium, whose experimental value is 2·36. Here W stands for the transition probability per unit time. Using the closure approximation, it is found that $R_\gamma = 0{\cdot}41$. The value of R_n is calculated by means of reasonable assumptions about the Fourier transforms of the initial and final state wave functions, and is found to be 2·72. From these values it follows that $R = 15{\cdot}7$. A.

539.18

8482. Capture of μ-mesons in heavy elements. J. W. KEUFFEL, F. B. HARRISON, T. N. K. GODFREY AND G. T. REYNOLDS. *Phys. Rev.*, **87**, 942–52 (*Sept.* 15, 1952).

Measurements have been made of the mean lifetimes of μ-mesons in several heavy elements. Time lags between the arrival of a cosmic-ray meson in the target and its subsequent absorption—as signalled by the neutrons and γ-rays following capture—are measured using large liquid scintillation counters and a chronotron timing circuit. The timing uncertainty is about 2×10^{-9} sec, and the counting rates are such that a mean life can be determined to an accuracy of 10% in about a week's run at sea level. A short-lived component of the decay curves was found and identified as due to neutrons from proton-induced stars. Errors from this effect were avoided. The latest results for the mean lives, in mμsec, are Fe 163 ± 27, Hg 58 ± 4, Cu 116 ± 9, Pb 76 ± 4, Sb 99 ± 11, Bi 68 ± 5. They are in agreement with the Wheeler Z^4_{eff} law up through Cu but disagree by a factor 3 for the heavier elements. They are in reasonable agreement with Kennedy's calculations (see following paper). The difference between the mean lives for Hg and Pb is also qualitatively predicted by Kennedy on the basis of a shell model of the nucleus. The results, together with Kennedy's calculation for Pb, allow of the conclusion that the μ-meson-nucleon coupling constant has the same value, within about 25%, as recent values of the coupling constants of β-decay and of the spontaneous disintegration of the μ-meson. A.

539.18

8483. μ-Meson capture and nuclear shell structure. J. M. KENNEDY. *Phys. Rev.*, **87**, 953–8 (*Sept.* 15, 1952).

The rate of absorption of negative μ-mesons in Pb and in Ca is calculated, using an interaction of the charge-exchange type described by Wheeler [Abstr. 3460 (1949)]. A shell model of the nucleus is used in making explicit calculations of the various nuclear matrix elements. The ratio of the absorption rate in Pb to that in Ca is found to be 6·1, in contrast to the value 14·3 predicted by the simpler Wheeler theory. Another result is that the absorption rate in Hg should be greater than that in Pb by 20% in spite of its smaller atomic number. These results are in fair agreement with recent experimental measurements. The coupling constant for the charge-exchange reaction is $g \sim 3\times10^{-49}$ erg cm^3, approximately the same as the coupling constants for β-decay and μ-decay. A.

539.18

8484. Nuclear cross sections for negative pions of energy 113 and 137 MeV. R. L. MARTIN. *Phys. Rev.*, **87**, 1052–60 (*Sept.* 15, 1952).

The measurements of the nuclear cross-sections for negative pions at 85 MeV, recently made by Chedester, Isaacs, Sachs, and Steinberger [Abstr. 7288 (1951)], have been extended to 113 and 137 MeV. The total absorption plus inelastic scattering cross-sections were obtained from a transmission measurement in poor geometry. The cross-sections are all close to geometrical value, $\pi A^{2/3}(\hbar/\mu c)^2$, within the accuracy (15%) of this technique. With the possible exception of C there is no evident energy dependence in the range 85 to 137 MeV. A.

539.18

8485. Surface production of charged mesons by photons on nuclei. S. T. BUTLER. *Phys. Rev.*, **87**, 1117–24 (*Sept.* 15, 1952).

An estimate has been made of the photoproduction cross-section of charged mesons from nuclei, and in particular from "surface-nucleons," i.e. the weakly interacting nucleons which make up the less dense nucleon atmosphere surrounding the main body of a nucleus. Comparison with experiment indicates that the production of mesons from the core of a nucleus is appreciably suppressed, apart from the effects of the initial momentum distribution of the nucleus, and of meson absorption. It is found, for example, that apart from having the correct $A^{\frac{2}{3}}$ dependence for the $\pi^+ + \pi^-$ cross-section, the surface production alone can account for large fractions of the observed yields, and because of differences in average binding between neutrons and protons in nuclei, gives π^-/π^+ ratios which have the same trends as a function of A as the observed ratios. A possible explanation of these results is that there occurs a large competing photo-disintegration process as a result of meson exchange effects between strongly coupled nucleons in the interior of a nucleus. A.

539.18

8486. On a theory of the capture of π-particles by the deuteron. I. YA. POMERANCHUK. *Zh. Eksper. Teor. Fiz.*, **22**, 129–35 (*No.* 2, 1952) *In Russian.*

The ratios of the probabilities of $p + \pi^- \rightarrow n + \pi^0$ to $d + \pi^- \rightarrow n + n + \pi^0$ and $p + \pi^- \rightarrow n + \gamma$ to $d + \pi^- \rightarrow n + n + \gamma$ are evaluated using a semi-phenomenological potential to represent the meson–nucleon interaction and without using meson theory. It is shown that an accurate determination of the number of π^0 from p and d may give the spins and parities of π and π^0. The general connection between slow meson processes in d and p is noted.

W. J. SWIATECKI.

539.18 : 537.591.1

8487. Concerning the varitron once again. (In answer to A. I. Alikhanyan on our paper on varitrons.). S. VERNOV, N. DOBROTIN AND G. ZATSEPIN. *Zh. Eksper. Teor. Fiz.*, **22**, 499–505 (*No.* 4, 1952).

Large discrepancies between the cosmic-ray mass spectra published by Alikhanyan *et al.* in 1949 and 1951 [Abstr. 7287 (1949), 2558–9 (1950), 6771–3 (1952)] are gloated over in detail. They are taken to indicate that the hodoscope system used is not yet sufficiently reliable. E. P. GEORGE

539.185

8488. Determination by the pile oscillator method of various effects due to the absorption of neutrons when slowing down. F. NETTER AND F. TYRODE. *C.R. Acad. Sci.* [*Paris*] **234**, 2448–50 (*June* 16, 1952) *In French.*

Samples of HfO_2, Sm_2O_3, U and HgO, sheathed in cadmium, were compared with standard boron samples. J. J. WILKINS

539.185

8489. Neutron energy measurements with a helium 3 filled proportional counter. R. BATCHELOR. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 674–5 (*Aug.*, 1952).

The energy of the fast neutrons was measured by using a proportional counter containing some He^3 to determine the energy of the disintegration products from the reaction: $He^3 + n \rightarrow H^1 + H^3 + 770$ keV. The half-width of the distribution was 150 keV for 560 keV neutrons from the $Li^7(p, n)$ reaction, part of this width was due to spread in neutron energy caused by target thickness and geometry (50 keV and 30 keV respectively). J. HUGHES

539.185 : 778.3

8490. A new photographic method for neutron velocity spectrography. II. P. M. ENDT AND C. H. PARIS. *Physica*, **18**, 387–98 (*June–July*, 1952).

In Pt I [Abstr. 9019 (1951)] the principles were presented of a new and simple method for neutron velocity spectrography. A more elaborate description of the apparatus and of some simple experiments to test its performance are given here.

STRUCTURE OF SOLIDS 539.2

539.211 : 539.2

8491. Evidence for inhomogeneities [of composition] in equilibrium solid solution. C. B. WALKER, J. BL[illegible] AND A. GUINIER. *C.R. Acad. Sci.* [*Paris*] **235**, 254–[illegible] (*July* 21, 1952) *In French.*

Measurements at low angles (0–10°) of the intensity as a function of angle, of X-rays scattered from a 20% Ag–Al alloy at temperatures of 525 and 600°

suggest the presence of small aggregates of up to 12 Ag atoms, more numerous than is to be expected in a truly random solid solution. Such aggregates are to be identified with the "nuclei" from which it is considered new phases grow. A. D. LE CLAIRE

539.217

8492. Autodiffusion coefficients of Cl^- in single crystals of NaCl. M. CHEMLA. *C.R. Acad. Sci.* [*Paris*] **234,** 2601–2 (*June* 30, 1952) *In French.*

See also Abstr. 6840 (1952). The diffusion coefficient of $^{36}Cl^-$ is measured in order to be compared with those of P^{32} and S^{35}, at temperatures between 650° and 760°C. It is found to be $7{\cdot}25\times10^{-11}$ cm^2 sec^{-1} at 650° and $2{\cdot}52\times10^{-9}$ at 762°, log D varying linearly with T^{-1}. The activation energy is found to be 2·70 eV. The diffusion coefficient is very much smaller than those of P^{32} and S^{35}, and about five times smaller than those of Na^+. A. J. TAYLOR

539.217

8493. Diffusion of barium in barium oxide. R. W. REDINGTON. *Phys. Rev.*, **87,** 1066–73 (*Sept.* 15, 1952).

The self-diffusion of Ba in single crystals of BaO has been measured as a function of temperature in the range from 550°K to 1520°K. Two diffusion processes were found. Measurement of the ionic mobility (with a tracer technique) showed that one of these processes was charge-transporting (~2 electronic charges) and the other was not. At temperatures below 1350°K the diffusion was "structure sensitive" and could be affected by previous heat treatment. The temperature dependence for the non-charge-transporting diffusion was $11 \pm 2{\cdot}2$ eV above 1350°K and $0{\cdot}44 \pm 0{\cdot}03$ eV below 1350°K. The corresponding figures for the charge-transporting diffusion were $12 \pm 2{\cdot}3$ eV and $0{\cdot}3 \pm 0{\cdot}05$ eV. The surface diffusion constant for Ba on BaO was also measured and had a temperature dependence of $0{\cdot}16 \pm 0{\cdot}03$ eV. A.

539.217 : 541.182.5

8494. Permanent forms of diffusion in a gel determined by the mutual precipitation of two reactants. J. SALVINIEN, J.-J. MOREAU AND R. GAUFRÈS. *C.R. Acad. Sci.* [*Paris*] **235,** 46–8 (*July* 7, 1952) *In French.*

The diffusion through a thin layer of gelatin of two substances which react to give a precipitate which is not protected by the gelatin is considered. It is possible to obtain the ratio of the diffusion coefficients of the two reactants from the geometry of the precipitation pattern. For $BaCl_2$ and $CuSO_4$ the ratio was 0·86, in good agreement with the value obtained by other methods. A. J. MEE

539.231

8495. Transparent conducting films of gold. *Nature* [*Lond.*] **170,** 236–7 (*Aug.* 9, 1952).

A further short article on conducting films on glass [see Abstr. 6080 (1952)]. The influence of the condition and material of a substrate film upon the properties of the superposed Au film is discussed.

539.234

8496. The effect of the temperature of preparation on the mechanical properties and structure of gelatin films. E. BRADBURY AND C. MARTIN. *Proc. Roy. Soc. A,* **214,** 183–92 (*Aug.* 21, 1952).

Gelatin films prepared by evaporation from aqueous solution at temperatures of 60°C and above differ considerably in structure and mechanical properties from films dried slowly at 20°C, when gelling precedes dehydration. In the high-temperature preparation dehydration precedes the formation of a continuous structure, and X-ray and other evidence indicates that the molecular chains are in a disordered contracted state not far removed from their condition in the sol. The high-temperature film is characterized by low strength and high recoverable extension under conditions of high relative humidity. In the low-temperature preparation the greater degree of crystallization has partially extended the molecular chains, and the unidirectional contraction of the film on drying has oriented them in the plane of the film. This film exhibits thermal contraction in hot methanol, and is stronger, but at high humidity is much less extensible, than the high-temperature preparation. A.

539.27

8497. Electron-microscope study of mineral dusts enclosed in silicotic pulmonary fibroses. A. POLICARD, A. COLLET AND L. RALYTE. *C.R. Acad. Sci.* [*Paris*] **235,** 224–5 (*July* 21, 1952) *In French.*

Study with the electron microscope, of silicotic pulmonary fibroses, has shown the presence of a considerable quantity of mineral dusts beyond the limits of optical microscopy (0·2 μ). There is no direct connection between the quantity of dust present and the intensity of the fibrosis at a given point. D. V. MABBS

539.27

8498. Biological smear preparations for electron optical studies. L. GRÜN AND W. TISCHER. *Optik,* **9,** 241–2 (*No.* 6, 1952) *In German.*

A method is described for examining, by direct or reflected light, smear preparations for use in electron microscopy. H. J. H. STARKS

539.27

8499. Electron micrographs of heteropolar proteic structures from sols having streaming birefringence. B. RYBAK AND M. BRICKA. *Experientia,* **8,** 265–6 (*No.* 7, 1952) *In French.*

Heteropolar proteic systems of which the anisotropy, determinated by means of streaming birefringence technique, can be compared with that of myosinic systems, and appear in the electronic microscope not like filaments, but like granules, more or less elliptic, two being often in coaxial bonds. Osmic fixation seems to favour these coaxial linkages with appearance of short filamentations. A.

539.27 : 621.385.833

8500. Specimen charging in the electron microscope and some observations on the size of polystyrene latex particles. S. G. ELLIS. *J. Appl. Phys.*, **23,** 728–32 (*July*, 1952).

From observations in the shadow electron microscope and the standard electron microscope it is concluded that specimen charging does not significantly change the magnification of the latter, provided that the specimen is less than a few microns in thickness and the illuminating electron beam simultaneously strikes a nearby grounded conductor such as the supporting mesh. The difference in size of shadowed

and unshadowed Dow Latex 580G, lot 3584 reported by Kern and Kern [Abstr. 7532 (1950)] is attributed to an added layer of material on the shadowed particles. Evidence in support of this view is presented, and the results of other workers are discussed in the light of it. A.

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.32 : 534.23

8501. A simple method of measuring the elastic constants with ultrasonic pulses. A. Lutsch. *Z. angew. Phys.*, **4**, 166–8 (*No.* 5, 1952) *In German.*

A quartz crystal acts as sender and receiver of sound pulses, those reflected from the end of the specimen are displayed on an oscilloscope with superposed time markers. Hence the velocity and absorption can be found and from the former the elastic constants calculated. J. E. CAFFYN

539.32 : 539.62 : 541.64

8502. Frictional and elastic properties of high polymeric materials. B. Lincoln. *Brit. J. Appl. Phys.*, **3**, 260–3 (*Aug.*, 1952).

The relationship of the elastic properties of solids to their frictional properties is discussed. By applying Hertz's equation for deformation of solids in contact, it is shown that while the asperities on metallic surfaces are deformed plastically even at the smallest loads, this is not necessarily true of materials having lower elastic modulus. This is confirmed by measurement of the area of contact between a nylon hemisphere and a glass surface, and by frictional measurements on various nylon specimens. It is shown further that the observed decrease in friction of some high polymers on rough surfaces may be explained in terms of elastic deformation of the asperities. A.

539.37

8503. The effect of frequency on the behaviour of rubber under cyclical deformation. D. M. Davies. *Brit. J. Appl. Phys.*, **3**, 285–8 (*Sept.*, 1952).

A new testing machine is described which records autographic hysteresis loops, and which has an unlimited low frequency range. Graphs are presented showing the variation of stiffness with frequency over the range 0·05–1000 c/min for a rubber with 60 parts of lamp-black. The overall variation can amount to anything up to 50%, depending on the amplitude. A range of amplitudes is covered in compression from 3–11% of the undeformed specimen height. The behaviour of the rubber is compared with that of the combined models of Maxwell and Voigt. A possible law emerges for the variation of stiffness in the frequency range 0–300 c/min where almost the entire variation occurs. Upwards of 400 c/min stiffness varies little. Further graphs show the variation of resilience; over the same range resilience falls anything up to 10% depending on the amplitude. Above 200–300 c/min again there is little variation. Similar tests on a gum-stock rubber with no carbon black showed negligible hysteresis, and the overall variation of stiffness with frequency was less than 7%. A.

539.373

8504. Theory of slipband formation. J. C. Fisher, E. W. Hart and R. H. Pry. *Phys. Rev.*, **87**, 958–61 (*Sept.* 15, 1952).

The fine structure of slip bands on the surfaces of plastically deformed crystals, as described by Heidenreich and Shockley [Abstr. 3513 (1949)] and by Brown [Abstr. 3923 (1952)], is explained in terms of the model of dislocation-loop generation proposed by Frank and Read [Abstr. 673 (1951)]. The back-stress at an active Frank–Read source, produced by an expanding avalanche of about 300 dislocation loops, is shown to be sufficient to stop dynamic loop generation at the source. Slip, therefore, occurs in avalanches separated in time. Avalanches from other slip systems crossing a slip plane containing an active source lead to the observed stepped surface markings, with successive avalanches from the given source displaced relative to each other.

539.385

8505. Experiments on the mechanics of rubber. III. Small torsions of stretched prisms. A. N. Gent and R. S. Rivlin. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 645–8 (*Aug.*, 1952).

For Pt II, see Abstr. 6799 (1952). A theorem, relating the torsional modulus for small torsions of a rod of incompressible highly elastic material, held in a state of simple extension, to the extension ratio and force necessary to maintain the extension, is verified experimentally for rods of vulcanized rubber of rectangular cross-section. A.

539.4.014

8506. On the theory of strain-hardening of metals. I. Electron density and mechanical defects in the lattice of plastically deformed copper. II. Electron density and chemical defects in the lattice of a solid solution of aluminium in copper. B. M. Rovinskiĭ. *Zh. Tekh. Fiz.*, **22**, 55–66 (*No.* 1, 1952) *In Russian.*

The correlation of data on X-ray scattering intensity and electron density distribution in alloys and cold-worked metals shows that lattice changes on plastic deformation and alloying are of a similar character. The respective mechanical or chemical defects produced determine the geometric lattice deformations of the static type (changes in the spectrum of elastic ion vibrations) or dynamic lattice deformations and bond alterations, resulting in both cases in strain-hardening and analogous changes of mechanical, physical and chemical properties. A. Gelbtuch

539.42

8507. Failure and fracture of metals as rate processes. T. Yokobori. Note in *J. Phys. Soc. Japan*, **7**, 122–3 (*Jan.–Feb.*, 1952).

The rate-determining process for failure is assumed to be the movement of dislocations and that for fracture, the growth of a crack nucleus. Equations developed from these hypotheses are successfully applied to experimental observations. A. D. Le Claire

539.434

8508. Low-stress torsional creep properties of pure aluminium. W. Betteridge. Letter in *Bull. Inst. Met.*, **1**, 76–7 (*May*, 1952).

The results of tests on specimens of differing

average grain size do not support the Kê hypothesis that the creep arises entirely from grain boundary flow, unless the boundary properties are modified by the different cold-working and annealing treatments applied to produce the different grain sizes. It is confirmed that such creep does not occur in single crystals. A. J. KENNEDY

539.434

8509. Low-stress torsional creep properties of pure aluminium. T. L. RICHARDS AND D. E. YEOMANS; A. J. KENNEDY. Letters in *Bull. Inst. Met.*, **1**, 106–8 (*Aug.*, 1952).

I. It is suggested that the Betteridge results (preceding abstract) may be explained by changes in texture with increased annealing temperature such that either (1) relative orientations decrease (with an increased boundary viscosity), or (2) the ⟨111⟩ fibre texture is progressively eliminated so that deformation occurs mainly within the grains by a process, noted by Jillson in Zn (1950), of simple plane rotation.

II. The results of Betteridge are shown to be reconcilable with the behaviour of fairly simple one- and two-mechanism models, although further experimental data is needed before any more fruitful interpretation can be made. A. J. KENNEDY

539.501

8510. Instrument for measuring dynamic viscosities and rigidities. H. MARKOVITZ, P. M. YAVORSKY, R. C. HARPER, JR, L. J. ZAPAS AND T. W. DEWITT. *Rev. Sci. Instrum.*, **23**, 430–7 (*Aug.*, 1952).

An instrument is described for measuring the dynamic rheological properties of viscoelastic liquids and solids. The design of this instrument is based on that of Goldberg and Sandvik, but differs from theirs in that it is not limited to use at a point of resonance. Examples are given of results obtained by its use on a Newtonian liquid, a viscoelastic liquid, and a viscoelastic solid. A derivation of the equation governing the instrument when used for solids is given in an appendix. A.

539.61

8511. Some mechanical and adhesive properties of indium. A. C. MOORE AND D. TABOR. *Brit. J. Appl. Phys.*, **3**, 299–301 (*Sept.*, 1952).

Experiments are described showing that (in the absence of surface contamination) the adhesion between In and metal surfaces depends only on the area of contact and on the time of breaking. The detailed behaviour may be correlated with the creep properties of In. With non-metals such as diamond, glass, thick metal oxides and certain plastics very strong adhesions to In are observed whilst with polytetrafluoroethylene, which has a very low coefficient of friction, the adhesion is negligibly small. These results suggest that in the sliding of non-metals, adhesion at the interface plays a part in the frictional mechanism analogous to the cold-welding process in the friction of metals. A.

539.62

8512. Metal transfer during static loading and impacting. E. RABINOWICZ. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 630–41 (*Aug.*, 1952).

Experiments are described which investigate the metal transfer which takes place when a radioactive hemispherically ended slider is pressed normally into a flat surface of the same or another metal. It is found that metal transfer in the form of a number of small fragments is always observed, and this supports the view that metallic junctions are formed between metal surfaces in contact. Experiments in which the load is varied suggest that at the higher loads the oxide layer on the metal surfaces is broken up to a larger extent than at lower loads, and a more than proportional increase in metallic interaction and transfer takes place. An analogous effect is observed in the presence of boundary lubricants. When the surfaces are impacted together, very similar results are obtained. Somewhat less pick-up is observed than for static loading, and the difference is probably due to the fact that it takes time for strong junctions to be formed. Impact experiments with surfaces covered by lubricants show that a lubricant layer may be trapped between the surfaces, and this produces a large reduction in pick-up without greatly reducing the amount of plastic deformation. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123.5

8513. A theoretical treatment of cation exchangers. I. The prediction of equilibrium constants from osmotic data. E. GLUECKAUF. *Proc. Roy. Soc. A*, **214**, 207–25 (*Aug.* 21, 1952).

The theories put forward to explain ion-exchange phenomena in natural and synthetic materials are examined. It is suggested that a reasonable interpretation of ion exchange in swelling materials can be made by treating the exchanger phase as a concentrated aqueous electrolyte. It is assumed (*a*) that the free energy of the exchanger is a function of its volume and its composition only and (*b*) that the exchanger phase obeys the laws of concentrated electrolyte solutions so far as they are known. The water uptake at different vapour pressures of polystyrene sulphonates of different degrees of cross-linking has been investigated for various monovalent cations. The data indicate that the anions do not contribute towards the statistical entropy terms of the solutions, but otherwise the osmotic coefficients of the monovalent cations have similar trends as in the case of strong 1 : 1 electrolytes. An approximate calculation may be made of the distribution constants of the exchangers when in contact with solutions containing two cations. With a few exceptions the values obtained are in reasonable agreement with both the absolute values and the trends observed experimentally for different ions, different cross-linkage and different solution compositions. A.

541.123.5

8514. A theoretical treatment of cation exchangers. II. Equilibria between an ion exchanger and an aqueous solution with a common cation. J. F. DUNCAN. *Proc. Roy. Soc. A*, **214**, 344–55 (*Sept.* 23, 1952).

The treatment of an ion exchanger as a concentrated aqueous poly-electrolyte is extended to cover the case of an exchanger saturated with a single cation which is in equilibrium with a solution containing a salt of the same cation. For this purpose equations are derived for the activity and osmotic coefficients of mixtures of 1 : 1 electrolytes with resinates giving only one mobile ion per equivalent. Applying these equations to experimental data, values of the "Harned" coefficients α_{12} and α_{21} are calculated. From these the absolute value of the activity coefficient of the H-resinate (using infinite dilution as the standard state) is deduced, which, taken in conjunction with the osmotic data of Pt I, enable the activity coefficient curve to be obtained, up to very high concentrations. This curve shows that at high concentrations there is less ion-pair formation for "resinates" of the sulphonated polystyrene type than is shown in aqueous solutions of the corresponding nitrates at the same ionic strength. A.

541.123.5 : 539.16

8515. Isotope effects in the exchange reaction between uncomplexed carbonate-bicarbonate ions and carbonate-*bis*-ethylenediamine-cobalt (III) ion. P. E. YANKWICH AND J. E. MCNAMARA. Letter in *J. Chem. Phys.*, **20**, 1325 (*Aug.*, 1952).

The equilibrium constants for the exchange reaction $Co(en)_2C^nO_3^+ + HC^xO_3^- = HC^nO_3^- + Co(en)_2C^xO_3^+$ (where $x = 13$ or 14, and n is the normal admixture of stable carbon nuclides) have been found to be: for the C^{13} exchange, $0{\cdot}99_1 \pm 0{\cdot}01_4$, and for the C^{14} exchange, $0{\cdot}99_0 \pm 0{\cdot}01_9$. F. LACHMAN

541.124

8516. Mechanisms of exchange and hydrogenation reactions of olefins. M. C. MARKHAM, M. C. WALL AND K. J. LAIDLER. Letter in *J. Chem. Phys.*, **20**, 1331–2 (*Aug.*, 1952).

Suggests a mechanism essentially of the Langmuir–Hinshelwood type, differing from those proposed by Wagner *et al.* [Abstr. 3960 (1952)] and by Twigg [Abstr. 1423 (1951)]. F. LACHMAN

541.124

8517. Stabilization of free radicals: its importance in reaction kinetics. Z. G. SZABÓ. Letter in *Nature* [*Lond.*] **170**, 246–7 (*Aug.* 9, 1952).

Addition of oxygen, NO, and other paramagnetic substances to free radicals which contain an odd number of electrons forms a more stable radical. The effect of this stabilization on the reaction rate and its dependence on the magnetic properties of the catalyst are discussed. G. I. W. LLEWELYN

541.124

8518. Relation between activation energy and frequency factor. M. SZWARC AND D. WILLIAMS. Letter in *Nature* [*Lond.*] **170**, 290 (*Aug.* 16, 1952).

In a series of kindred reactions the activation energies seem to be functionally related to the frequency factors. This may be due to the variation in the nature of the solvents, which affects the degree of solvation of the transition state. Such relations do not hold for series of kindred unimolecular reactions in the gaseous phase. This is shown by data for a number of unimolecular dissociations of monobromides. It is found that, although the activation energies vary a great deal, the frequency factors are approximately constant. A. J. TAYLOR

541.124

8519. The pyrolysis of benzoyl bromide and the determination of the relevant bond dissociation energies. M. LADACKI, C. H. LEIGH AND M. SZWARC. *Proc. Roy. Soc. A*, **214**, 273–80 (*Aug.* 21, 1952).

541.124

8520. The kinetics of the thermal decomposition of branched-chain paraffin hydrocarbons. I. *iso*-butane, *iso*-pentane and *neo*-pentane. M. G. PEARD, F. J. STUBBS AND C. HINSHELWOOD. **Appendix.** C. J. DANBY. *Proc. Roy. Soc. A*, **214**, 330–8 (*Sept.* 23, 1952).

541.124

8521. The kinetics of the thermal decomposition of branched-chain paraffin hydrocarbons. II. The isomeric hexanes. M. G. PEARD, F. J. STUBBS AND C. HINSHELWOOD. *Proc. Roy. Soc. A*, **214**, 339–43 (*Sept.* 23, 1952).

541.124 : 539.16

8522. The effect of the isomeric transition in Br^{80} on its reactivity with the tetrachlorides of carbon, silicon, germanium, and tin. C. C. COFFIN AND W. D. JAMIESON. Letter in *J. Chem. Phys.*, **20**, 1324–5 (*Aug.*, 1952).

Summarizes results in which no obvious parallel could be noted between the transient equilibrium amounts of 20-min Br^{80} activity acquired by the different tetrachlorides and any one of their relevant properties. F. LACHMAN

541.124 : 541.14

8523. The thermal and photochemical decomposition of H_2O_2 vapor in the presence of foreign gases. F. S. STONE AND H. S. TAYLOR. Letter in *J. Chem. Phys.*, **20**, 1339–41 (*Aug.*, 1952).

Presents in two graphs and one table the results of a study on the thermal ($t > 90°C$) and photochemical (ultraviolet light) decomposition of H_2O_2 vapour, using N, CO, He, CH_4, C_2H_6 and NH_3 as carrier gases, at various transfer rates. F. LACHMAN

541.126

8524. A note on spherical explosion waves in gaseous mixtures. N. MANSON AND F. FERRIÉ. *C.R. Acad. Sci.* [*Paris*] **235**, 139–40 (*July* 16, 1952) *In French.*

Mixtures with air or O_2 of (*a*) C_2H_2, (*b*) C_3H_8, (*c*) $C_2H_4 + CH_4$ + minor amounts of other hydrocarbons, (*d*) town gas, mainly CH_4, contained in spherical rubber balloons 40–60 cm dia., were ignited centrally by (A) a hot wire, (B) a 12-joule spark, (C) an electric igniter cap, (D) an explosive detonator. Flame propagation was recorded by a rotating-drum camera (speed approx. 0·1 mm/μsec). In mixtures with O_2, detonation was not set up by hot-wire ignition, but using igniters (B) and (C) it did occur in mixtures of C_2H_2–O_2. Detonation was initiated by igniter (D) in all cases when the oxidant was O_2, but in no case when the oxidant was air. The mixture

limits of detonation are narrower than for detonation in tubes, although the detonation velocity is the same (within 5% exptl. error). A. SCHOFIELD

541.128 : 539.234

8525. Catalysis on evaporated metal films. I. The efficiency of different metals for the reaction between ammonia and deuterium. C. KEMBALL. *Proc. Roy. Soc. A*, **214**, 413–26 (*Sept.* 28, 1952).

The exchange reaction between NH_3 and D has been followed on evaporated films of Pt, Rh, Pd, Ni, W, Fe, Cu and Ag by means of a mass spectrometer. In all cases the initial product was deutero-ammonia (NH_2D), and the other deutero-ammonias were formed by successive reactions. Despite a considerable variation in the catalytic activity from metal to metal the relative concentrations of the deutero-ammonias formed throughout each reaction were identical in every case, and differential equations are developed to show that this is a consequence of the fact that only one H atom is exchanged at a time. The energies of activation varied from 5·2 kcal/mole for Pt to 14·1 kcal/mole for Ag and there is a correlation between the energies of activation and the work functions of the metals. The frequency factors were almost identical on all the metals except W. Possible mechanisms for the reaction are discussed. The catalysis of the exchange reaction by films of oxidized Cu, W, Ni and Zn and by ZnO was also investigated. A.

ELECTROCHEMISTRY 541.13

541.135.5

8526. Electrode reactions in alternating fields. II. The dynamic capacitance. B. BREYER AND S. HACOBIAN. *Aust. J. Sci.*, **14**, 153–4 (*April*, 1952).

Develops a new expression for the dynamic capacitance, based on the new equation for the "a.c. active space" [Abstr. 6138 (1952)]. It has been found that the phase angle of the alternating current is a measure of the reversibility of the electrode process. F. LACHMAN

541.135.5

8527. Overvoltage produced at redox electrodes for several consecutive potential determining steps. K. J. VETTER. *Z. Naturforsch.*, **7a**, 328–33 (*May*, 1952) *In German.*

The average overvoltage has been derived for redox electrodes, which is the result of several consecutive different electronic transitions. The mechanism derived for simple systems by Butler (1932) and Volmer (1930) has been employed, and the various exchange current densities and other factors which arise, and which depend on anodic and cathodic overvoltages, have been evaluated. Criteria are thereby derived for electrodes with several potential determining steps, and the resistance at equilibrium potential is computed. In like manner, the partial potential determining steps can be determined from the potential-concentration dependence of the exchange current densities, and the complete mechanism interpreted. There are 17 references. H. H. HODGSON

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.15

8528. Formation and decomposition of hydrogen peroxide in water irradiated with α rays from polonium. M. DO CARMO ANTA AND M. HAISSINSKY. *C.R. Acad. Sci.* [*Paris*] **235**, 170–2 (*July* 16, 1952) *In French.*

The polonium salt was dissolved in strong acid to ensure uniform distribution, and no other reagent was added until after the irradiation. In 0·8N H_2SO_4, H_2O_2 was produced. The yield depended on the Po concentration and decreased with time. The quantity of H_2O_2 tended towards a limiting value which was also observed at other acid concentrations. In 0·8N $HClO_4$, similar results were obtained; but in 0·8N HNO_3, no H_2O_2 was formed. The effects of α-rays from polonium on water and H_2O_2 are thus more complex than, and differ from, those of α-rays from radon. C. B. ALLSOPP

541.15

8529. Some effects of ionizing radiation on the formation of bubbles in liquids. D. A. GLASER. Letter in *Phys. Rev.*, **87**, 665 (*Aug.* 15, 1952).

The effect of ionizing radiation on the stability of diethyl ether at 130°C indicates increase of bubble formation on exposure to the radiation. G. I. W. LLEWELYN

DISPERSIONS . COLLOIDS . ADSORPTION 541.18

541.182.6 : 535.434

8530. Size distribution of spheres by light scattering. F. BUECHE. Note in *J. Amer. Chem. Soc.*, **74**, 2373 (*May* 5, 1952).

The range of sizes of spherical particles in solution is determined from measurements of the position of the first angular intensity minimum [see Abstr. 9074 (1950)] at two different wavelengths. If an approximate rectangular distribution is considered, its limiting radii can then be obtained using equations due to Dandliker (*J. Amer. Chem. Soc.*, **72**, 5112 (1950)]. An example is given. D. G. AVERY

CHEMICAL STRUCTURE 541.2/.6

541.57

8531. Carbon-carbon bond lengths. R. T. SANDERSON. *Science*, **116**, 41–2 (*July* 11, 1952).

Discusses deviations from "expected" values of C–C bond lengths. The lengthening in C_2F_6 is attributed to electrostatic repulsion of the formal like-charges on the C atoms, and the thermal stability to attraction between unlike charges on C and remote F atoms. Bond shortening in systems where the C–C bond is joined to multiple bonds is also discussed. H. H. GREENWOOD

541.62

8532. Isomerism of monosubstituted derivatives of cyclohexane. M. LARNAUDIE. *C.R. Acad. Sci.* [*Paris*] **235**, 154–6 (*July* 16, 1952) *In French.*

The structure with symmetry D_{3d} for cyclohexane is assumed to possess the lower energy. For this molecule two monosubstituted isomers are possible (κ and ε). Earlier work [O. Hassel and H. Viervoll (1942), Beckett, Pitzer, Spitzer (1947)] has only proved the existence of isomer κ. Infrared spectra were taken of methyl, halogen and deuterium derivatives in liquid and vapour. The analysis of the spectra shows the existence of the ε isomer for the halogen and deuterium derivatives, especially in the liquid phase. Moments of inertia were calculated. It is concluded that there exists an equilibrium between the two isomers. The barrier height is estimated for C_6H_{12} and $C_6H_{11}D$ (4500 cm^{-1}); it will be higher for compounds with bigger substituents. A. J. TAYLOR

541.64 : 532.72

8533. Diffusion of polymers in solutions. S. E. BRESLER, S. A. PAVLOVA AND P. A. FINOGENOV. *Zh. Tekh. Fiz.*, **21**, 1061–5 (*No.* 9, 1951) *In Russian.*

No skew curves have been obtained by the authors for the diffusion of polyvinyl acetate polymer in ethyl acetate, and of polystyrene in ethylbenzene, when the temperature variations in the thermostat did not exceed 0·005°c. It has also been found that the viscosity/temperature curves for these solutions of polymers have no peculiar points. F. LACHMAN

541.64

8534. Studies in chain transfer. II. Catalyzed polymerization of methyl methacrylate. S. BASU, J. N. SEN AND S. R. PALIT. *Proc. Roy. Soc. A*, **214**, 247–62 (*Aug.* 21, 1952). For Pt. I, see Abstr. 8308 (1950).

541.64 : 539.3

8535. The problem of the elastic distensions of polymers. E. I. BARG, D. M. SPITKOVSKIĬ AND N. N. MELTEVA. *Dokl. Akad. Nauk, SSSR*, **84**, 257–60 (*No.* 2, 1952) *In Russian.*

The object of the investigation was to obtain the characteristics of the flexibility of polymer chains of polyvinyl acetates by finding the maximum of the reversible distension. The chains may exhibit different flexibilities according to the value of the intramolecular potential barrier or to the energy differences of the isomers of revolution. A theoretical consideration, based on a table of the r.m.s. values of the distance between the ends of an isolated macromolecule, calculated for chains of various lengths and degrees of polymerization, shows that the steric effect in linear polymers results in braking their rotation about the simple bonds and making the chain longer than it would be, could it rotate quite freely. The experimental investigation yielded reversible elongations of polyvinyl acetate molecules tens of times greater than the theoretical values, making it probable that other polymers with flexible chains might behave similarly. The explanation suggested is that this may be due to the interaction of the linked molecules which is neglected in the kinetical theory of high elasticity. B. F. KRAUS

541.65

8536. Complexes of iodine with an ether and an alcohol. J. S. HAM. Letter in *J. Chem. Phys.*, **20**, 1170 (*July*, 1952).

Spectroscopic study gives strong u.v. transitions which cannot be correlated with either component molecule of the complex. H. H. GREENWOOD

CHEMICAL ANALYSIS 543/545

545.82

8537. A new atomizer for flame photometry. R. HERRMANN AND H. SCHELLHORN. *Z. angew. Phys.*, **4**, 208–10 (*No.* 6, 1952) *In German.*

A new device which requires much smaller quantities of test solutions than usual. S. T. HENDERSON

545.82

8538. On the role of Zn as the third alloy component in the spectroscopic investigation of the system Al–Mg. J. VAN CALKER AND R. WIENECKE. *Z. angew. Phys.*, **4**, 210–15 (*No.* 6, 1952) *In German.*

In the presence of Zn the relative intensities of Mg lines are scarcely altered, but those of Al are variously affected with an increasing prominence of spark lines as the Zn concentration increases. In an A atmosphere the effect is reduced. The results of varying the discharge conditions, and of introducing electrodes of foreign metals, are discussed. S. T. HENDERSON

CRYSTALLOGRAPHY 548

548.24 : 539.373

8539. Twinning. R. CLARK AND G. B. CRAIG. *Progress in metal physics*, vol. 3, pp. 115–39 (1952) [See Abstr. 8617 (1952)].

A review. A description of growth and deformation twins and the method of their identification is followed by a more detailed discussion of the twin crystals which occur in face-centred cubic and hexagonal metals. The effects of the presence of twins on deformation are discussed, as are the effects of impurities, rates of stress and temperature on twin formation in α-iron. The movement of atoms during the process is discussed. The occurrence of twins in other metals (rhombohedral metals, β-tin) is also briefly considered. 102 references. E. P. WOHLFARTH

548.

8540. Crystallography of transformations. J. S. BOWLES AND C. S. BARRETT. *Progress in metal physics*, vol. 3, pp. 1–41 (1952) [See Abstr. 861 (1952)].

A review. (i) Martensite transformations.

general statement of the distinctive features of martensite transformations is followed by a discussion of the fact that the total atomic displacement during the transformation is small. The methods of determining the orientation relationships and atomic movements from crystallographic data are described and the variously proposed mechanisms of these changes are discussed. A discussion of the mode of development of martensite plates is given and related problems, e.g. those concerning stacking faults, are considered. (ii) Nucleation and growth transformations [see also Abstr. 6922 (1950)]. Orientation relationships are discussed and the habit of the precipitating phases in this type of transformation is considered. The occurrence of metastable transition states in metals and alloys is also discussed. 90 references. E. P. WOHLFARTH

548.5

8541. Recrystallization and grain growth. J. E. BURKE AND D. TURNBULL. *Progress in metal physics*, vol. 3, pp. 220–92 (1952) [See Abstr. 8617 (1952)].

A review. A statement of the "laws" of recrystallization is followed by a theoretical discussion of the kinetics of the process; the results of experiments are discussed on the basis of this theory. The effects of time, orientation, temperature, strain and other variables on the nucleation frequency and the linear rate of grain growth are discussed and the experimental results interpreted theoretically. The theory of recrystallization nuclei is outlined. A discussion is given of the process of grain growth after recrystallization. Recrystallization textures and annealing twins are also discussed. 110 references. E. P. WOHLFARTH

548.5

8542. Structure of crystal boundaries. B. CHALMERS. *Progress in metal physics*, vol. 3, pp. 293–319 (1952) [See Abstr. 8617 (1952)].

A review of work published since 1949 [for earlier work see Abstr. 6922 (1950)]. Observations on the free energy of grain boundaries [Abstr. 4471 (1950), 2077 (1951)] are interpreted on the basis of dislocation theory [Abstr. 7592 (1950)]. The problem of making absolute rather than comparative energy determinations is discussed. Twin boundaries, the occurrence of slip at crystal boundaries and interphase boundaries are also considered. 38 references. E. P. WOHLFARTH

548.5

8543. A simple method of obtaining a large single crystal of sodium nitrate. T. YAMAGUTI. Note in *J. Phys. Soc. Japan*, **7**, 113 (*Jan.–Feb.*, 1952).

548.5

8544. Observation of spiral growth figures on crystals of natural quartz and of cast alumina. A. R. WEILL. *C.R. Acad. Sci.* [*Paris*] **235**, 256–8 (*July* 21, 1952) *In French.*

Further evidence [see also Abstr. 4734 (1952)] for the crystal-growth theory of Burton, Cabrera and Frank [Abstr. 6560 (1951)]. A. R. STOKES

548.5

8545. Single synthetic cadmium sulfide crystals. S. J. CZYZAK, D. J. CRAIG, C. E. MCCAIN AND D. C. REYNOLDS. Letter in *J. Appl. Phys.*, **23**, 932–3 (*Aug.*, 1952).

Single crystals of CdS have been grown by a method similar to that of Reynolds and Czyzak [Abstr. 9100 (1950)]. The crystals grow as hexagonal prisms $3 \times 3 \times 6$ mm. Absorption, luminescence and photoconduction characteristics are reported.

G. F. J. GARLICK

548.5

8546. The growth from the melt of single crystals of low melting point metals. A. J. GOSS AND S. WEINTROUB; Discussion, K. E. PUTTICK. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 561–72 (*Aug.*, 1952).

The results of a series of experiments on the preparation of Sn, Pb, Zn and Bi single crystals in the form of rods are given. The effects on the crystallization of various thermal factors, in particular the temperature gradient and the rate of growth, are studied and the results for the four metals are compared. A.

548.5

8547. Asymmetry of texture in cubic crystals grown from the melt. P. R. ROWLAND. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 572–4 (*Aug.*, 1952).

Careful electro-polishing of single-crystal spheres of Cu (face-centred cubic system) grown from the melt has revealed that they appear to consist of a number of parallel crystallites of square cross-section with their lengths parallel to the [001] axis which lies nearest in direction to the "direction of growth" in the melt. A.

548.5

8548. The growth of thallium bromo–iodide crystals. K. M. GREENLAND. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 574–5 (*Aug.*, 1952).

Crystals of thallium bromo–iodide, or KRS-5, are transparent to radiation of wavelengths between $0{\cdot}5\ \mu$ and about $40\ \mu$. This note briefly describes the growing of KRS-5 single crystals and their optical working. The crystals are grown in vertical cylindrical crucibles by a progressive freezing of the melt from bottom to top. The physical, chemical and mechanical properties of the material are summarized. A.

548.5

8549. Growth of zinc sulfide single crystals. W. W. PIPER. Letter in *J. Chem. Phys.*, **20**, 1343 (*Aug.*, 1952).

The crystal is grown in a sealed quartz tube in a furnace, at a rate of up to 5 mgm per day. The resulting crystals show some stacking disorder.

A. R. STOKES

548.5 : 534.23

8550. Crystallization of organic substances under the influence of ultrasonic waves. A. P. KAPUSTIN. *Zh. Tekh. Fiz.*, **22**, 765–72 (*No.* 5, 1952) *In Russian.*

Two methods of investigating the effect of ultrasonics on crystallization are described. It is shown for a number of substances that new centres of crystallization are formed, the number being proportional to the field strength and the degree of supercooling. In glass-like substances a large number of centres of crystallization are produced by the influence of ultrasonic waves. J. M. HOUGH

548.5 : 535.345

8551. Growth of crystals of caesium bromide, and the infra-red transmission limit in optical materials. A. C. G. MENZIES. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 576–8 (*Aug.*, 1952).

Following the development of methods for growing single crystals of materials having good optical properties, the search has been intensified for new substances. One such is CsBr, and this has been grown by the Kyropoulos–Pohl method of drawing from the melt; a modification of the standard process is described. In the search for new materials, it is useful to have some way of predicting the useful long-wavelength transmission limit, and a rule is stated which forms a useful guide. A.

548.5 : 536.424

8552. Impurity effects in the thermal conversion of germanium. W. P. SLICHTER AND E. D. KOLB. Letter in *Phys. Rev.*, **87**, 527–8 (*Aug.* 1, 1952).

Experiments involving growth of Ge crystals, where some parts of the crystal are heated for much longer periods than others during the pulling process, and others involving contamination of the surface by copper salts before heating, suggest that the thermal conversion of Ge is due to rapid diffusion of Cu from the surface. C. A. HOGARTH

548.5 : 539.16

8553. Enclosure of cerium by potassium nitrate crystals carried out with Ce^{144} as indicator. J. PAULY. *C.R. Acad. Sci.* [*Paris*] **235**, 40–2 (*July* 7, 1952) *In French.*

When potassium nitrate crystallizes out from a solution containing also traces of cerium nitrate, some cerium is enclosed in the crystals. When radioactive Ce is used, this quantity can be determined. This has been carried out in solutions of various pH. A big portion of the impurity is found in the outer regions of the crystals; inside the proportion of Ce and K is constant for big and small crystals, and proportional to the relative concentration of Ce in the solution. A. J. TAYLOR

548.538

8554. On the orientation relations between cementite and α-iron. J. J. TRILLAT AND S. OKETANI. *Acta Cryst.*, **5**, 469–71 (*July*, 1952) *In French.*

Single-crystal films of Fe–α have been formed by evaporation on to a cleavage face of NaCl heated to 600–700°C followed by annealing at 700°C. The single-crystal preparations of Fe–α have been cementized at 500°C in an atmosphere of $CO + H_2$ and then examined by electron diffraction. It was found that the cementite is orientated on the single crystal of iron as follows: (001) Fe–α parallel to (111) Fe_3C; (110) Fe–α parallel to (1$\bar{2}$1) Fe_3C. Prolonging the reaction leads to a progressive disorientation of the cementite. A.

548.574

8555. Etch spirals on a diamond octahedron face. S. TOLANSKY AND M. OMAR. Letter in *Phil. Mag.* **43**, 808–9 (*July*, 1952).

Etching in KNO_3 and $NaCO_3$ at 525°C gave rise to spiral chains of triangular etch pits. Photomicrographs and interferograms are reproduced.

A. R. STOKES

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

8556. The study of elastic waves in the body-centred cubic lattice of α iron. H. CURIEN. *Bull. Soc. Franç. Minér. Crist.*, **75**, 197–230 (*April–June*, 1952) *In French.*

Taking into account the interactions of each atom with its 26 1st, 2nd and 3rd nearest neighbours a secular equation is derived relating the frequency, wavelength and direction of propagation of lattice waves. Due to the high symmetry of the cubic lattice the secular equation contains only seven independent constants, the "atomic coefficients," these being the second derivatives of the lattice energy with respect to various displacements, relative to one atom, of its 26 neighbours. The 7 atomic coefficients are related through 3 equations to the usual elastic constants c_{11}, c_{12} and c_{44}. Various simplifying hypotheses on the nature of the interatomic forces are considered. It is inadequate to assume that these are wholly central or that only 1st neighbour interactions need be taken into account, for such assumptions lead respectively to the results that $c_{11} = c_{12}$ (Cauchy relation), and that $c_{11} = c_{44}$, both at variance with experiment. To assume that there are central forces, but only between atoms which are other than 1st nearest neighbours, reduces the number of independent atomic coefficients to 4 in the general case considered and to 3 if 3rd neighbour interactions are ignored. The thus simplified relations between the elastic constants and the atomic coefficients are without obvious objection and may be tested experimentally to check the assumptions made. It is shown how, from the secular equation, may be obtained the dispersion curves giving the frequency as a function of wavelength of transverse and longitudinal waves propagated along the directions of the principle symmetry axes. Finally, a method is described for determining from diffuse X-ray scattering measurements the frequency spectrum of lattice vibrations and numerical values of the atomic coefficients. Experimental results on α–Fe are to be presented later and discussed in terms of the foregoing theory so as to obtain information on the nature of the interatomic forces.

A. D. LE CLAIRE

548.7

8557. The theory of the mechanical stability of crystal lattices. V. A. ZHDANOV AND V. F. KONUSOV. *Zh. Eksper. Teor. Fiz.*, **22**, 339–49 (*No.* 3, 1952) *In Russian.*

The displacement deformation of a simple lattice, limited by the uniform deformation permissible, is examined; inner distortion is not observed but must be present. Calculation of the internal distortions for special cases leads to new possibilities for the reorientation of the lattice, in particular to the appearance of a hexagonal lattice. A quantitative picture of the processes of reorientation and breakdown by slipping will be complicated and will be supplemented by polymorphic transitions of the second order leading to the hexagonal lattice (which must be metastable). An estimate is made of the energy of activation of the process of reorientation. A. L. MACKAY

548.7

8558. On the determination from lattice theory of the energy of distortion in simple ionic crystals. P. BRAUER. *Z. Naturforsch.*, **7a**, 372–9 (*May*, 1952) *In German.*

The lattice theory for simple ionic crystals is applied to crystals which are distorted by defect structure or impurities. It is shown that Tl^+ ions may be introduced freely into KCl but not into NaCl, in accordance with Pringsheim's observations [Abstr. 7143 (1950)]. A. R. STOKES

548.7

8559. Screw dislocations in quartz. B. T. M. WILLIS. Letter in *Nature* [*Lond.*] **170**, 115–16 (*July* 19, 1952).

Evidence for screw dislocations is obtained from a photo-micrograph and a two-beam interference photograph of a quartz ($10\bar{1}1$) face. A. R. STOKES

548.7

8560. Theory of color centers. I. On Mollwo's relation and the temperature variation in *F* absorption band. T. NAGAMIYA. *J. Phys. Soc. Japan*, **7**, 354–7 (*July–Aug.*, 1952).

A very simple derivation of the well-known Mollwo relation between ionic distance and *F* maximum absorption frequency, is given. Then, following Inui and Uemura's idea, the variation in the position and the breadth of the *F* absorption band with temperature is correlated with the variation and the fluctuation in ionic distance by thermal motions. Finally, a formula for the concentration of *F* centres in equilibrium with alkali vapour is given, taking into account the change in vibrational frequency of the positive ions adjacent to *F* vacancies. Numerical value for the parameter characterizing this change is computed by comparing with experiment the formulas for the temperature dependency of the *F* band and for the concentration of *F* centres. A.

548.7

8561. Theory of color centers. II. On the nature of V_3 center in alkali halides. T. NAGAMIYA. *J. Phys. Soc. Japan*, **7**, 358–60 (*July–Aug.*, 1952).

The same interpretation of the V_3 centre as that of Seitz is given. The energy of formation of a V_3 centre in the crystal from a molecule of a halogen gas is computed and compared with Pohl's observation. The computed value in the case of KBr is 1·4 eV as compared with the observed value 1·2 eV. The mobility of V_3 centres at high temperature is discussed and a theoretical formula is derived for it. The computed value of the activation energy for the mobility in KBr is 1·2 eV, while the corresponding observed value is 0·7 eV. A.

548.7

8562. Generation of color center precursors in alkali halides by electrolysis. M. HACSKAYLO AND G. GROETZINGER. *Phys. Rev.*, **87**, 789–95 (*Sept.* 1, 1952).

Two types of imperfections (designated as colour centre precursors) are created in NaCl crystals when they are subjected to electrolysis. Both of these types are present in a crystal not coloured by the electrolysis and lead upon irradiation by X-rays to the development of temporary colour centres in much larger numbers than are ordinarily produced and to permanent centres in about the same numbers as result when a crystal is directly coloured by electrolysis. In crystals coloured directly by electrolysis, only the former type of precursor is present. The properties of crystals containing precursors and of those containing colour centres derived from precursors have been studied and compared with those of crystals in the other previously known states. A proposal regarding the nature of the second type of precursor is presented. A.

548.7

8563. Formation energy of superlattice for Ni_3Fe. I. Co-operative formation of superlattice at the critical temperature. S. IIDA. *J. Phys. Soc. Japan*, **7**, 373–9 (*July–Aug.*, 1952).

Variations of inner energy for Ni_3Fe with time of annealing at critical ordering temperature 490°C are observed first by measuring the excess specific heat of the specimen annealed with various durations, and secondly by measuring the rate of decrease of inner energy at 490°C, using a new experimental method in which the necessary difference of temperature between the specimen and the surrounding wall for keeping the specimen at constant temperature 490°C is measured. Then, the variation of inner energy shows a tendency of two-step character which had been observed before now for many other physical quantities of this alloy. Next, this phenomenon has been analysed as a simple superposition of two kinds of formation processes, i.e., a formation of short range order, which starts abruptly from the beginning and ends at about 15 hours of annealing, and a formation of long range order, which begins with a sufficiently small rate, increases gradually to its maximum at 20 ~ 30 hours and then decreases to zero at about 60 hours of annealing. A.

548.7

8564. The energy spectrum of electrons in ionic crystals (case of strong coupling). S. V. TYABLIKOV. *Zh. Tekh. Fiz.*, **22**, 325–31 (*No.* 2, 1952) *In Russian.*

Recent investigations into the polarization of the crystal lattice by an electron are reviewed. From the Hamiltonian representing the system of coupled electrons and phonons it is concluded (using trial wave functions appropriate to strong coupling) that the energy spectrum of an electron in the field produced by its own polarization is in the form of zones, whether the coupling is strong or not. The effective mass of those "polarons" may be hundreds of electron masses. W. J. SWIATECKI

548.7 : 539.152.2

Nuclear electric quadrupole interaction in single crystals. *See Abstr.* 8401

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 8497–500

548.732

8565. Transmission of X-rays through calcite near the Bragg angle. G. L. ROGOSA AND G. SCHWARZ. *Phys. Rev.*, **87**, 995–8 (*Sept.* 15, 1952).

Transmitted and diffracted intensities of monochromatic X-ray radiation through single crystals of calcite have been recorded. Wavelengths between 0·631 Å and 2·29 Å and crystal thicknesses from

0·1 mm to 3·06 mm were used. A double crystal spectrometer served as monochromator. Intensities were measured with a Geiger counter. The measurements permit an angular correlation between the transmitted and diffracted curves to within one second of arc. The results show an anomalous absorption near the Bragg angle. Characteristically different results are obtained depending on the crystal thickness and the wavelength. For "thin" crystals the transmitted intensity decreases at the Bragg angle. For "thick" crystals the transmitted intensity increases at the Bragg angle. At each particular wavelength there exists a region of "intermediate" crystal thicknesses for which the transmitted intensity passes through a maximum and minimum as the crystal is rotated through the Bragg angle. A.

548.733

8566. Wire-shaped anticathodes: application to the diffraction of X-rays by crystals. J. BARRAUD AND C. PIERRÉE. *C.R. Acad. Sci.* [*Paris*] **235,** 72–4 (*July* 7, 1952) *In French.*

Using a tungsten wire as target in the X-ray tube described [Abstr. 3616 (1952)] a focused Laue photograph of quartz was obtained. The application to texture study is discussed. A. R. STOKES

548.733

8567. Production of symmetrical half Debye–Scherrer transmission patterns, with filtered radiation. A.-J. ROSE. *C.R. Acad. Sci.* [*Paris*] **235,** 74–6 (*July* 7, 1952) *In French.*

A camera is described having the specimen on the surface of a cylinder carrying the film, giving symmetrical photographs, with high dispersion, up to Bragg angle 45°. A. R. STOKES

548.734

8568. A graphical method for determining a system of parameters and indices in the cubic, tetragonal, hexagonal and orthorhombic crystal systems. S. L. NUDELMAN. *Zh. Tekh. Fiz.*, **22,** 773–83 (*No.* 5, 1952) *In Russian.*

The method, when suitable charts have been drawn up, is said to permit the indexing of powder photographs by unskilled personnel. A. L. MACKAY

548.734

8569. Upper level precession photography and the Lorentz-polarization correction. I–II. R. D. BURBANK (321–7); H. J. GRENVILLE-WELLS AND S. C. ABRAHAMS (328–31). *Rev. Sci. Instrum.*, **23,** 321–31 (*July*, 1952).

The precession camera can be used to record the entire reciprocal lattice out to 1 r.l.u. using one crystal orientation. For the data so recorded to be useful it is necessary to have the Lorentz polarization correction (L.p.) in some convenient form. The correction has been computed at about 1300 points in reciprocal space. The computation is presented in Pt I as a series of sections showing 1/L.p. as a function of ξ and ζ at constant values of τ. In Pt II the correction is presented as a function of ξ and τ at constant values of ζ, where the sections at constant ζ have been obtained by graphical means from the sections at constant τ. A.

548.734

8570. Evjen's method of evaluating the Madelung constant. K. S. KRISHNAN AND S. K. ROY. *Phys. Rev.*, **87,** 581–2 (*Aug.* 15, 1952).

A convenient method of evaluating the Madelung series is first to group the terms into unit cells and then sum the contributions from the different cells. It is emphasized that even such a grouping, which involves neighbouring terms only, may affect the sum. This happens, for example, with the CsCl type of lattice, if the unit cell chosen is the usual body-centred cube, whereas by choosing an oblique elementary cell containing one ion, the sum remains unaltered. A criterion is given for the choice of a suitable elementary cell. A.

548.734 : 539.3

8571. Quantitative X-ray diffraction observations on strained metal aggregates. G. B. GREENOUGH. *Progress in metal physics, vol.* 3, *pp.* 176–219 (1952) [See Abstr. 8617 (1952)].

A review. A brief discussion of the general experimental techniques is followed by a discussion of results obtained for elastically strained aggregates. Deviations between theoretical and experimental values of the stress/strain ratio are discussed. Results for plastically strained aggregates are outlined. Deductions which may be made from the movement, broadening and intensity changes of the X-ray diffraction lines on straining are fully discussed. 114 references. E. P. WOHLFARTH

548.735

8572. Statistical criterion for testing structure models on the basis of the intensities of X-ray reflections. K. DORNBERGER-SCHIFF. *Z. phys. Chem.*, **200,** 70–80 (*July*, 1952) *In German.*

See Abstr. 6902 (1952). If a model is proposed giving the positions of part of the atoms in a structure, the average intensity of the reflections will be equal to the sum of the average intensity due to the atoms belonging to the model and the average intensity due to the rest: $\langle I\rangle = \langle I_m\rangle + \langle I_r\rangle$. For testing the correctness of the model the observed intensities are arranged in increasing order of the intensity calculated for the model only, and averaged in suitable batches. If the model is correct $\langle I\rangle_{\text{batch}}$ will increase linearly with I_m, and $\langle I - I_m\rangle_{\text{batch}}$ will oscillate about a constant value $\langle I_r\rangle$. If the model is wrong the opposite will occur: $\langle I\rangle_{\text{batch}}$ will oscillate about a constant value $\langle I\rangle$, and $\langle I - I_m\rangle_{\text{batch}}$ will decrease linearly with I_m. A. J. C. WILSON

548.735.44

8573. A "megamolecular" structure factor. D. WRINCH. Letter in *Phil. Mag.*, **43,** 801–4 (*July*, 1952).

A Fourier transform has been calculated for the "cage" structure proposed by the writer (1937, 1948) for proteins. A. R. STOKES

548.735.6

8574. A simple method of determining orientation in recrystallized wires of the cubic system. T. S. HUTCHISON. *J. Sci. Instrum.*, **29,** 257–8 (*Aug.*, 1952).

A simple optical method of determining the type and degree of orientation, where the grain size is greater than 10^{-2} cm is described. Standard physics laboratory equipment is used. A.

548.736 : 536.424

On the phase transition in cuprous oxide. *See Abstr.* 8124

548.736.1

8575. The anomalous lattice constants of very small crystals of certain metals. N. A. SHISHAKOV. *Zh. Eksper. Teor. Fiz.*, **22**, 241–5 (*No.* 2, 1952) *In Russian.*

It has been shown that Pt in very thin layers has a lattice constant which is 1·5% larger than that of the bulk metal and that Al, thought to be pseudomorphic in such conditions, has the normal lattice.

A. L. MACKAY

548.736.3

8576. Lattice constants of zinc oxide. T. B. RYMER AND G. D. ARCHARD. Letter in *Research* [*Lond.*] **5**, 292 (*June*, 1952).

$a = 3{\cdot}24961 \pm 0{\cdot}00002$ Å; $c/a = 1{\cdot}60220 \pm 0{\cdot}00004$ at 20°C. The effects of traces of Cd and Pb, of exposure to air, and of small departure from hexagonal symmetry, were investigated. A. R. STOKES

548.736.4

8577. Lattice constant of $PbZrO_3$. E. SAWAGUCHI. Note in *J. Phys. Soc. Japan*, **7**, 110–11 (*Jan.–Feb.*, 1952).

A study of the variations in lattice parameters from 20°C to 400°C, with reference to the change of structure at 230°C and the Curie point for antiferroelectricity at 220°C. A. R. STOKES

548.736.6

8578. Summarized proceedings of a conference on structures of silicate minerals—London, November 1951. K. ROBINSON AND E. R. S. SHAW. *Brit. J. Appl. Phys.*, **3**, 277–82 (*Sept.*, 1952).

Papers and discussions summarized at about 200 words each. Subjects were: "Dicalcium silicate structures" (A. M. B. Douglas); "Crystal structure of β dicalcium silicate" (C. M. Midgley); "Unusual X-ray diffraction effects shown by mono- and tri-calcium silicates" (J. W. JEFFERY); "Crystallography of the hydrated calcium silicates" (H. F. W. Taylor); "The crystal structure of afwillite" (H. D. Megaw); "The thermal decomposition of afwillite" (K. M. Moody); "The crystal structure of dicalcium silicate and hydrate" (L. Heller); "The crystal chemistry of hydration of silicate systems" (J. D. Bernal); "X-ray examination of Portland cement by powder methods (H. G. Midgley); "The tetrahedron framework of the felspar structure" (W. H. Taylor); "X-ray analysis of clay mineral structures" (G. W. Brindley); "Interlamellar reactions of montmorillonite and related minerals" (D. M. C. MacEwan); "Crystal structures of chlorites" (K. Robinson and B. M. Oughton); "Asbestos minerals" (E. J. W. Whittaker); "Diffraction by randomly superposed layers in a clay mineral" (G. Brown and R. Greene-Kelly); "Some considerations arising from Fourier syntheses of vermiculite" (A. Milne, A. McL. Mathieson and G. F. Walker). 39 refs.

548.737

8579. X-ray study of the thermal decomposition of Prussian blue. S. BARBEZAT AND J.-J. TRILLAT. *J. Rech. Cent. Nat. Rech. Sci.*, **4**, 184–6 (*June*, 1952) *In French.*

Heating in a sealed tube produces no changes up to 200°C and only slight changes at 250°C. Heating in air causes change in structure to an amorphous, non-magnetic maroon-coloured modification. Above 280°C this passes to $Fe_2O_3 + Fe_3O_4$. Debye–Scherrer photographs are reproduced. A. R. STOKES

548.737

8580. Evidence for globulite molecules in horse hemoglobin. D. WRINCH. Letter in *J. Chem. Phys.*, **20**, 1332–3 (*Aug.*, 1952).

See also M. F. Perutz [*Proc. Roy. Soc. A*, **195**, 474 (1949)]. The general structure types of the haemoglobin molecules in crystalline horse methaemoglobin are discussed on the basis of Perutz's X-ray work. A. J. TAYLOR

GEOPHYSICS 55

550.341

8581. Relations between changes of rotation, and free oscillation of the earth, and earth tremors. N. STOYKO. *C.R. Acad. Sci.* [*Paris*] **234**, 2550–2 (*June* 23, 1952) *In French.*

Data covering the period, 1906–44, has been used to examine the connections between the energy associated with deep tremors (T); the annual perturbation of terrestrial rotation period (R); amplitude (A), and period (P), of the Chandlerian polar displacement. The computed correlation coeffs. are: (TP), 0·866; (RP), 0·875; (TR), 0·886; (TA), 0·896; (RA), 0·902; (PA), 0·910. D. R. BARBER

550.362

8582. Remarks on the paper of I. I. Tsukkerman "Determination of thermal constants by probes." A. G. TEMKIN. *Zh. Tekh. Fiz.*, **22**, 340–1 (*No.* 2, 1952) *In Russian.*

See Abstr. 7623 (1950). Points out an error in the final formula for the plane probe, and gives simpler formulae for two cases of a spherical probe.

F. LACHMAN

550.373 : 550.383

8583. Rapid variation in the telluric currents and the terrestrial magnetic field. Y. BEAUFILS, G. GIBAULT AND G. KUNETZ. *C.R. Acad. Sci.* [*Paris*] **235**, 198–200 (*July* 16, 1952) *In French.*

Experiments made at the same station show a very high correlation between the variation in the telluric current and the horizontal component of the earth's magnetic field. J. M. HOUGH

ATMOSPHERE . METEOROLOGY 551.5

551.508.26 : 551.508.71

8584. A new, very sensitive, temperature-humidity measuring apparatus. W. Hesse. *Arch. Meteorol. Geophys. Bioklimatol. B*, **3**, 168–71 (1951) *In German.*

Describes, with photos and wiring diagram, a new electric dry and wet instrument developed in Leipzig for exploration by auto. Accurate to 0·01°C and 0·1% R.H., no lag. METEOROLOGICAL ABSTRACTS

551.51

8585. Results of rocket and meteor research. F. L. Whipple. *Bull. Amer. Met. Soc.*, **33**, 13–25 (*Jan.*, 1952).

Results are presented of rocket and meteor research in the upper atmosphere during the past three years. Both methods have been valuable in determining the pressures, densities and temperatures in the upper atmosphere and variations with time and place above an altitude of 30 km. The basic atmospheric data are now rather well determined to 130 km over New Mexico. Knowledge of the composition of the atmosphere to 72 km depends solely upon rocket sampling techniques. A great deal of information has been obtained from the rocket measures concerning radiation from the sun in the far ultraviolet to wavelength about 800 Å and in the soft X-ray region below 20 Å. A considerable section of the paper is devoted to the question of micro-meteorites, their existence and effect on the upper atmosphere. In addition, three Appendixes include some more recent information concerning temperatures and composition of the upper atmosphere and concerning high-frequency solar radiation. A.

551.510.41

8586. A quantitative determination of the abundance of telluric CO above Columbus, Ohio. J. H. Shaw and J. N. Howard. Letter in *Phys. Rev.*, **87**, 380–1 (*July* 15, 1952). **Absorption by telluric CO in the 2·3 μ region.** J. N. Howard and J. H. Shaw. *Ibid.*, **87**, 679 (*Aug.* 15, 1952).

Careful measurements of the curve of growth of the B(2) line in the 0–1 absorption of CO at 4·7 μ, based on spectrograms obtained on 6 different days, Jan.–Feb. 1952, indicate that, on these occasions, the average amount of CO above Columbus, Ohio, was 0·09 atm.-cm per air-mass. The contribution of solar CO is assumed negligible. Previously, Goldberg, McMath, Mohler and Pierce [see Abstr. 3228 (1952)] had not been able to detect any CO absorption in the overtone band at 2·3 μ at two widely separated locations. This region has been examined also, and a curve of growth constructed for the P(6) line of the 0–2 band, based on observations of 6–8 March, 1952. The abundance of atm. CO determined from this curve is 0·10 atm. cm per air-mass, in good agreement with that obtained from the 0–1 band measures. D. R. BARBER

551.510.41 : 551.593.5

8587. Optical phenomena present at a lunar eclipse. H.-K. Paetzold. *Z. Astrophys.*, **30**, 282–92 (*No.* 4, 1952) *In German.*

The effects of the earth's atmosphere on the colour, changes of brightness, and shadow boundary of the eclipsed moon are discussed in relation to the atm. O_3 layer. The existence of a weak terrestrial absorbing layer of variable thickness at *c.* 100 km appears probable. D. R. BARBER

551.510.41 : 551.593.5

8588. Further determinations of vertical distribution of [atmospheric] ozone at lunar eclipses. H.-K. Paetzold. *Z. Naturforsch.*, **7a**, 325–8 (*May*, 1952) *In German.*

Results obtained by the optical method (see also preceding abstract) at the eclipses of Sept. 1932, Feb., Aug. 1943, are discussed. They indicate heights of max. O_3 concentration between 16 and 25 km and are in good agreement with those obtained from balloon ascents. A seasonal effect is shown, the altitude of max. O_3 being *c.* 2 km lower in spring than in summer. D. R. BARBER

551.510.535

8589. The half-yearly period of the *F*2 layer ionization. O. Burkard. *Arch. Meteorol. Geophys. Bioklimatol. A*, **4**, 391–402 (1951) *In German.*

Harmonic analysis of *F*2-layer ionization at numerous stations shows a strong half-year periodicity. Latitude distribution of phase and amplitude are discussed. The variation is provisionally explained by the assumption that solar u.v. radiation varies with latitude. METEOROLOGICAL ABSTRACTS

551.510.535

8590. Weak echoes from the ionosphere with radio waves of frequency 1·42 Mc/s. S. Gnanalingam and K. Weekes. Letter in *Nature* [*Lond.*] **170**, 113–14 (*July* 19, 1952).

Improved sensitivity using a frequency-modulation method has enabled measurements to be made on 1·42 Mc/s throughout days of high absorption in winter, when the conventional pulse system on 2 Mc/s failed to show any echo. The reflection heights appear to be in the ranges 75–80, 90–95 and 100–112 km (ordinary *E*-region). G. M. BROWN

551.510.535 : 523.78

8591. Some observations on the effect of solar eclipse on the *F*2 region of the ionosphere. S. S. Banerjee, V. D. Rajan and P. C. Banerjee. Letter in *J. Sci. Industr. Res.*, **11B**, 197–8 (*May*, 1952).

Measurements made at Banaras, India, for the eclipse of Feb. 25, 1952, show a sudden drop in *f F*2 about 2 hr before the optical eclipse started, and no additional drop during the period of the eclipse. These suggest that solar neutral particles may contribute to the ionization in the *F*2-region. Records of the fading of short-wave signals support these observations and also show that the thickness of the *F*2-region was larger on the eclipse day than on the previous and subsequent days. G. M. BROWN

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 8353–7

551.510.535 : 621.396.11 : 621.396.9 : 621.317.39

8592. A new method for ionospheric height measurement. H. Rakshit and S. D. Chatterjee. Letter in *Sci. Cult.*, **17**, 520 (*June*, 1952).

The conventional c.r.t. display with single-line time base for pulse-sounding limits the accuracy of height

measurements to $\pm 2 \cdot 5$ km. A new method based on measuring the delay time necessary to obtain coincidence between the probing pulse and a sharp trigger pulse generated at the receiver site increases this accuracy to $\pm 0 \cdot 75$ km. G. M. BROWN

551.513

8593. Theory of development and of thickness patterns. G. C. McVittie. *Tellus*, **4**, 8–20 (*Feb.*, 1952).

The equations of motion, of continuity, of vorticity and of heat-transfer are transformed from co-ordinates (x, y, z) to co-ordinates (x, y, p) without the use of the hydrostatic equation in the vertical. An approximation based on the empirical fact that the isobaric surfaces are slightly inclined to the horizontal together with the use of dimensionless variables, gives the hydrostatic equation and simplifies the fundamental equations by the rejection of many of their terms. Thereafter definitions of certain types of geostrophic and nongeostrophic motions lead, respectively, to (*a*) Rossby's potential-vorticity equation; (*b*) the development and thickness-patterns theory of R. C. Sutcliffe, which is discussed in detail; and (*c*) J. G. Charney's (1949) treatment of the equivalent barotropic atmosphere. These models of atmospheric motions are compared and contrasted. A.

551.513 : 525.35

8594. The seasonal fluctuations of the terrestrial globe's rotation and the general circulation of the atmosphere. F. H. van den Dungen, J. F. Cox and J. van Mieghem. *Tellus*, **4**, 1–7 (*Feb.*, 1952) *In French.*

Seasonal fluctuations in the rate of rotation of the earth are detected when checking the best clocks with astronomical time. These variations may be shown to result from transfer of momentum between the atmosphere and the globe. As a consequence, the study of these fluctuations may bring interesting information in the field of meteorology. A.

551.515.4 : 538.566.2

8595. Recent developments in radio location of thunderstorm centers. W. J. Kessler and S. P. Hersperger. *Bull. Amer. Met. Soc.*, **33**, 153–7 (*April*, 1952).

The location of thunderstorms through observations of the directions of arrival and the instantaneous intensity variations of the electromagnetic radiations produced by the associated lightning discharges is described. The method of triangulation (θ_1, θ_2), employed by the Air Forces during World War II, and the proposed single-station (R, θ) technique currently under investigation at the University of Florida are discussed. A.

551.521

8596. On the determination of the energy flux of the extraterrestrial solar radiation. M. Nicolet. *Arch. Meteorol. Geophys. Bioklimatol. B*, **3**, 209–19 (1951) *In German.*

In view of recent criticisms of Abbot's solar constant of 1·94 cal/cm²/min, the author re-examines spectral distribution of solar radiation from photosphere. Abbot's u.v. correction is nearly confirmed but his infrared correction of 0·037 is raised to 0·063. A corrected solar constant of 1·98 is obtained which should be used in solar investigations, and a revised table in watts/m² from 0·22–7 μ to replace Linke's is given. A new absolute determination is required.

METEOROLOGICAL ABSTRACTS

551.521

8597. Experimental investigations leading to a standard of daylight. R. Schulze. *Comm. Int. Eclair.* [*CIE*] *12th Mtg*, 1951. *Volume* 2, *Paper Nn*, 6 *pp.* (1952) *In German.*

Studies of the spectral distribution of sunlight and of skylight described in the paper lead to a proposal to base the standard of daylight on the spectral distribution of the total light received on a horizontal surface when the sun's altitude is 35°. The illumination is measured by means of an integrating sphere with a large horizontal diffusing window.

J. W. T. WALSH

551.571

8598. Humidity of the upper troposphere and lower stratosphere over Southern England. J. K. Bannon, R. Frith and H. C. Shellard. *Geophys. Mem. Meteorol. Off.* [*Lond.*] **11**, 36 *pp.* (*No.* 88, 1952).

Observations of air temperature and frost-point temperature made on 130 high-altitude flights, usually to heights of 38 500 ft (international standard atmosphere) or above, are presented. The observations are analysed with respect to their height above or below the tropopause thus emphasizing any differences between troposphere and stratosphere. Correlation coefficients between frost points and other parameters at various levels are evaluated. Frost points at fixed levels are analysed to show the variation between different synoptic (circulation) types, between different seasons and between different air masses. Changes in frost point in passing through frontal surfaces are discussed and attention is drawn to some observations made in the neighbourhood of jet streams. A.

551.573

8599. Further experiments on evaporation from small, saturated, plane areas into a turbulent boundary layer. D. R. Davies and T. S. Walters. *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 640–5 (*Aug.*, 1952).

See *Quart. J. Mech. Appl. Math.*, **4**, 466 (*Dec.*, 1951). Describes an experimental investigation designed to evaluate the effect of width and length on rates of evaporation from small, saturated, plane, rectangular areas placed in a turbulent boundary layer. An approach is made to the problem of estimating the distribution of temperature on the evaporating surface by using a number of thermojunctions situated at various points under the surface. The higher rate of evaporation near the edges of the area is well illustrated by this method, greater temperature differences between the surface and air stream being observed near the edges due to greater latent heat effects. Provided the crosswind width of the evaporating area is not less than about half the downwind length, Sutton's two-dimensional solution of this limited area problem is found to lead to tolerable accuracy in the circumstances tested. A.

551.578.1

8600. Effects of sunlight and ammonia on the action of silver-iodide particles as sublimation nuclei. S. E. Reynolds, W. Hume, II, and M. McWhirter. *Bull. Amer. Met. Soc.*, **33**, 26–31 (*Jan.*, 1952).

Tests involving exposure of AgI smoke to bright

sunlight show a decrease in concentration of effective nuclei (at −20°C) of approximately two orders of magnitude per hour. The concentration of effective nuclei is increased greatly (as much as two orders of magnitude) by the addition of a little ammonia vapour to the AgI smoke. Smoke samples which have been deactivated completely by exposure to u.v. light can be caused to form large numbers of ice crystals by the addition of ammonia vapour. If ammonia is added before exposure to light, the rate of decay is the same or greater, and the effectiveness cannot be restored by further addition of ammonia. The effect of ammonia is believed to be due to the adsorption of ammonia on the NaI surfaces or to the formation of an ammine of NaI. A.

551.578.1

8601. Correlation of chloride particle abundance with the synoptic situation on a cross-country flight. W. D. CROZIER, B. K. SEELY AND L. B. WHEELER. *Bull. Amer. Met. Soc.*, **33**, 95–100 (*March*, 1952).

An account is given of the collection of airborne chloride particles, by airplane, on a cross-country flight. The accompanying meteorological situation is described. The distribution of chloride particles found is consistent with the view that they originated in the Gulf of Mexico and in the Pacific off the coast of Mexico. The greatest abundance of chloride particles was found east of the mountains in southern California, in air that probably came from the region of a tropical storm. A.

551.578.11

8602. On the content of nitrogen (NH_4–N, and NO_3–N) in atmospheric precipitation. A. ÅNGSTRÖM AND L. HÖGBERG. *Tellus*, **4**, 31–42 (*Feb.*, 1952).

The concentration of NH_4–N and NO_3–N is dependent upon the amount of precipitation previously fallen. A mathematical expression is given for this and a computation made of the normal supply of nitrogen at Uppsala, using known normal frequencies of different amounts of precipitation. A pronounced dependence of the concentration on the character of the air mass has been found to exist. Thus the tropical air contains between 10 and 30% greater amount of nitrogen than the polar air, and almost double the amount found in the arctic air. A.

551.590.22

8603. Insufficiency of a statistical proof of the influence of the moon on atmospheric precipitation. W. VAN DER BIJL. *C.R. Acad. Sci.* [*Paris*] **235**, 22–3 (*July* 7, 1952) *In French.*

A criticism of Mineur's recent work [see Abstr. 3151 (1952)] based on the application of 7 independent statistical criteria to the data used in the original investigation. It is concluded that terrestrial precipitation is wholly independent of the lunar phases. D. R. BARBER

551.591

8604. Visual measurements of atmospheric transmission of light at night. C. A. PEARSON, M. J. KOOMEN AND R. TOUSEY. *Bull. Amer. Met. Soc.*, **33**, 117–21 (*March*, 1952).

Measurements of the visual transmission of the atmosphere were made at night across Chesapeake Bay over a period of two years. A visual telephotometer was used to measure the illumination produced at a distance of 8·77 sea miles by a series of calibrated light sources. With this range it was possible to measure atmospheric transmission values between 0·4 and 0·9 per sea mile corresponding to daylight visual ranges from 4 to 40 sea miles with an accuracy of ±2%. Under stable atmospheric conditions the data obtained at night were in good agreement with direct observations of the daylight visual range made before sunset and after the following dawn. A.

551.593.9 : 535.24

8605. New visual photometer for the night sky [light]. H. GARRIGUE. *C.R. Acad. Sci.* [*Paris*] **235**, 34–6 (*July* 7, 1952) *In French.*

A detailed description of an all-metal, low-brightness, portable instrument of improved precision suitable for use in all climates. Visual matching is made with a source whose spectral distribution follows closely that of the night sky. D. R. BARBER

551.594.12

8606. Calculation of the ionization due to radioactive substances in the ground. B. HULTQVIST. *Tellus*, **4**, 54–62 (*Feb.*, 1952).

In earlier calculations it seems not to have been considered that the penetrating γ-radiation from the ground can, independent of the density and composition of the ground, be expressed by the simple formula $I = C \times S$, where S is the proportion of radioactive element in g/g and C is a constant. Formula for the ionization in the case when the ground is covered with an absorber of greater density than air, or when the radiation travels through air for long distances, are derived. The ionization from various minerals is calculated and is found to agree in magnitude with measured values. Curves, showing the decrease in the ionization as a function of the depth of snow cover, are given for three different values of snow density. The decrease in the dose rate with the altitude above the earth's surface is shown graphically. A.

551.594.

8607. Forbidden line of N II in the aurora. W. PETRIE. *Phys. Rev.*, **87**, 1002 (*Sept.* 15, 1952).

A feature of the auroral spectrum is the presence of moderately intense O II and N II permitted lines and the apparent absence of lower energy level forbidden lines of the same ions. A weak feature at 5755 Å has been detected in high dispension aurora spectrograms, and this is interpreted as due to the forbidden N II transition $^1D - {}^1S$. The likely cause of the weakness of O II and N II forbidden lines is discussed. A.

BIOLOGY 57/59

578.08 : 539.16.08

8608. Thorium B labelled red corpuscles. E. ALEXANDER. *Ark. Kemi*, **4**, 363–8 (*Paper* 23, 1952).

The ThB produced in rabbit blood by decaying Th is found to be almost quantitatively taken up by the corpuscles. Only 2% of the total ThB content remain in the plasma phase. A similar result is obtained when a solution of ThB + C collected originally in an electric field is dissolved in blood. Also the distribution between plasma and corpuscles of RaD obtained from tubes which contained formerly radon was found to be essentially the same. The uptake of ThB labelled lead by the corpuscle phase was much less pronounced. The ThB content of the plasma phase amounted in this case to 16% of the total activity of the blood. The Bi isotopes ThC and RaE show no pronounced preference for the corpuscle phase and are found in about equal amounts in equal weights of plasma and corpuscles. A.

578.088.5 : 539.166.92

Electron energies and ion densities in water irradiated with 200 keV, 1 MeV and 25 MeV radiation. *See Abstr.* 8440

578.088.7 : 621.395.645

8609. A radiofrequency-coupled input stage for biological amplifiers. L. HAAPANEN. *Rev. Sci. Instrum.*, **23**, 337–9 (*July*, 1952).

A description is given of an ungrounded input circuit consisting of a miniature radiofrequency transmitter, the carrier of which is modulated by the signal under investigation. After being transmitted to a receiver the carrier is demodulated, filtered, and the resulting signal used as the input to the standard amplifier. This method results in achievement of a high discrimination against interfering potentials without need to select closely matched components. An especially valuable feature is the elimination of the baseline shifts which often mask the recorded potentials when using a strong stimulus and recording with the differential amplifier. A.

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.843.31

8610. Selective stimulation of color receptors with alternating currents. K. MOTOKAWA AND M. EBE. *Science*, **116**, 92–4 (*July* 25, 1952).

Accordingly, as sinusoidal a.c. or rectangular pulses were used, somewhat different results were obtained when the threshold voltage causing a phosphene was plotted against the frequency of the stimulating current. The resulting curve exhibited more or less well defined minima which are identified in an interesting manner with the excitability curves, previously obtained (1949). Unfortunately, the writers give no direct clue as to the retinal region examined. 3 figs. are given. R. A. WEALE

612.843.613 , 612.858.71

8611. The minimum limits of the intensity of sound and light acting on the organs of hearing and sight. G. V. GERSHUNI. *Zh. Tekh. Fiz.*, **21**, 1202–4 (*No.* 10, 1951) *In Russian.*

Using experimental techniques described previously, based on Pavlov's method of conditioned reflexes, it was shown that conditioned reflexes can be discovered at intensities of sound and light which are lower than the minimum intensities (thresholds) necessary for causing auditory and visual sensations; e.g. sub-threshold intensities for sounds of 1000 c/s gave rise to conditioned reflexes at intensities of *c.* 8 decibels lower than the average threshold intensity. W. HUGHES

615.849

8612. 1000 curie cobalt units for radiation therapy. *Brit. J. Radiol.*, **25**, 296–313 (*June*, 1952).

I. The Saskatchewan cobalt 60 unit. H. E. JOHNS, L. M. BATES AND T. A. WATSON (296–302).

A description of this Co unit is given. Detailed drawings of the head show the mounting of the Co^{60} source, its protection, and collimation of the beam. Schematic diagrams, plan and elevation, of the treatment room, show the wall thickness, mechanical hoist for the head, and position of the rotating treatment table. The transfer of the Co^{60} sources from the Chalk River pile, and their loading into the apparatus, are described. The output of the unit, and its surrounding stray radiation are dealt with briefly.

II. Depth dose data and diaphragm design for the Saskatchewan 1000 curie cobalt unit. H. E. JOHNS, E. R. EPP, D. V. CORMACK AND S. O. FEDORUK (302–8).

Methods of achieving a low skin dose are considered. Depth dose data for circular fields at different source-distances are presented; variation of % depth-dose with area and source-distance is discussed. The effects of the position and thickness of the limiting diaphragm on isodose distributions have been investigated. In the light of this experimental work, suitable treatment cones have been designed. Scale diagrams of these are given.

III. Design of a cobalt 60 beam therapy unit. D. T. GREEN AND R. F. ERRINGTON (309–13).

The translation of the physical problems involved into engineering realities is described. The Co^{60} source delivers about 30 r/min at 1 m, and stray radiation at all exposed surfaces is less than 6·25 mr/hr. Safety precautions in operation are detailed. An "exploded" and labelled diagram of the head is shown. The head is mobile, and the whole supporting structure simple and compact.

IV. Radiation measurements with the Eldorado cobalt 60 teletherapy unit. W. R. DIXON, C. GARRETT AND A. MORRISON (314–18).

A thick-walled Victoreen chamber in a masonite phantom was used to make measurements of surface output and backscatter. Other workers' values are compared. Depth-dose measurements were made in

a water phantom by means of a probe ionization chamber coupled to a d.c. amplifier, and tables are given for various field sizes to depths of 30 cm. Comparison of this Co^{60} beam with X-rays shows it to be equivalent in depth-dose to a 3-MeV X-ray beam, though for Co^{60} the irradiated area is more sharply defined. D. V. MABBS

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8613. Design and construction of a multicurie cobalt teletherapy unit. A preliminary report. L. G. GRIMMETT, H. D. KERMAN, M. BRUCER, G. H. FLETCHER AND J. E. RICHARDSON. *Radiology*, **59**, 19–31 (*July*, 1952).

The unit has been designed to take a 1250 curie Co^{60} source (dimensions $2\times2\times1$ cm), the effective strength of which, allowing for self-absorption, will be 1000 curies, giving a dose rate of 90 r/min at 50 cm. Once installed, the source is permanently kept inside the tungsten alloy shielding head, and is switched from the "on" to the "off" position by mounting it on the edge of a disk which is rotated through 180° with respect to the treatment portal. Flaking of radioactive cobalt oxide is an important hazard, and details are given of a sealed source container which minimizes this risk. The rotating mechanism, the beam collimator and the field limiting diaphragms are described, together with the building which houses the unit, and measurements (using a 200 curie source) show the degree of radiation protection achieved. The method of loading the source is given in detail: it is carried out under water, and uses an intermediate massive lead container to hold the source whilst some of the operations are being completed. L. E. MUSSELL

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8614. Preliminary depth dose studies with a 70 MeV synchrotron. A. F. HOLLOWAY AND H. JANZEN. Letter in *Brit. J. Radiol.*, **25**, 393–4 (*July*, 1952).

Measurements in a Plexiglass phantom, using condenser chambers, show distributions across the beam (with no collimation) and along central axis, for 130 cm between target and phantom. Semi-angle of beam is found to be 1·4° and depth of maximum dose 7·3 cm in phantom or 9 cm in water. F. T. FARMER

616–07 : 534.321.9

8615. Ultrasonic ranging for cancer diagnosis. J. M. REID AND J. J. WILD. *Electronics*, **25**, 136–8 (*July*, 1952).

Pulsed ultrasonic radiation of 15 Mc/s and peak power 1 kW is applied from a crystal through a water column to the body. Echoes are observed on a c.r. tube from discontinuities in tissue, and tests on 20 patients show that breast and also brain tumours may be detected. F. T. FARMER

616–073.75 : 539.16.08

8616. Diagnostic studies with radioactive isotope tracers. K. E. CORRIGAN AND H. S. HAYDEN. *Radiology*, **59**, 1–18 (*July*, 1952).

A description in detail is given of the techniques in use at Harper Hospital, Detroit, concerning malfunction of the thyroid gland and its diagnosis with I^{131}. Significant cases in the various disease categories, with surgical and histological confirmation, and retention and excretion curves, are shown and discussed. Diagrams of apparatus and survey charts used are given. No case diagnosed as non-malignant has subsequently proved malignant (1754 cases to date). Emphasis is laid on the necessity and advantages of painstaking and accurate Geiger-counter surveys. D. V. MABBS

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669 : 548

8617. Progress in metal physics, Vol. 3. B. CHALMERS [Ed.]. *London, Pergamon Press* (1952) 320 *pp.*

For Vol. 2, see Abstr. 7439 (1951). For abstracts of separate chapters see Abstr. 8147, 8312, 8362, 8539–42, 8571 (1952). E. P. WOHLFARTH

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778.5 : 537.523.4

8618. [Physical] basis of spark cinematography. H. SCHARDIN AND E. FÜNFER. *Z. angew. Phys.*, **4**, 185–99 (*No.* 5, 1952) *In German.*

A detailed review, with 53 references, of the physical properties of spark discharges which are relevant to the techniques of spark photography. Spark circuits are described. There is a brief discussion of spark mechanisms. Finally, sections on pulsed X-ray sources and on vacuum discharges are given. J. D. CRAGGS

778.5 : 537.523.4

8619. [Physical] basis of spark cinematography. H. SCHARDIN AND E. FÜNFER. *Z. angew. Phys.*, **4**, 224–38 (*No.* 6, 1952) *In German.*

A continuation of a previous paper (preceding abstract). The present paper discusses the luminous efficiency of various spark sources, and gives results for various flash lamps, etc. The use of Kerr cell magneto-optic and image converter cameras is also described. Circuits are given where necessary and 16 references. J. D. CRAGGS